PLAIN DEALER, DECEMBER 18, 1977

# NASA tests 'atom splitter' as treatment for cancer

A cyclotron at NASA Lewis Research Center now is being used in an experimental cancer treatment program, Lewis and the Cleveland Clinic Foundation announced yesterday.

The instrument, built originally for research into space nuclear propulsion systems, was modified to direct a stream of neutrons at cancer tissue.

The cyclotron is a type of "atom smasher" that breaks down atoms into particles through use of high voltage electricity and magnetism. The neutron is one such particle.

Dr. Antonio R. Antunez, head of radiation therapy for Cleveland Clinic and medical director of the cyclotron program, said neutrons have more powerful biological effects than X rays or other radiation used in cancer therapy.

"We don't know whether these effects will be good or bad," he said, adding that neutron therapy had shown beneficial results on certain tumors.

"It is still largely an investigative technique. We view the program as a challenging opportunity to evaluate this relatively new approach to radiation treatment," he said.

Cleveland is the fourth community where trials are under way. Other neutron treatment centers are in Houston, Tex., Washington, D.C., and Batavia, Ill.

Dr. William S. Kiser, chairman of the clinic's board of governors, said the program will be financed for three years by a $519,000 grant from the National Cancer Institute.

The clinic paid $200,000 for modifications in the Lewis cyclotron.

Patients to be treated at Lewis will be selected by physicians throughout the Great Lakes area.

"To be a suitable candidate for neutron therapy, a patient must have a tumor that has not spread and which cannot be treated effectively by conventional procedures such as surgery, cobalt, x-ray or chemotherapy," Dr. Antunez said.

In the procedure at Lewis, the physician will determine the amount of raidation the patient is to receive and enter this and other information on a keyboard terminal connected to a computer.

The paitient's exposure will be continuously monitored and automatically terminated when the proper dosage has been given.

Dr. Bernard Lubarsky, acting director of Lewis, said, "It is always gratifying to be able to transfer space technology to the health field. Whatever progress we make in this team approach will be well worth the effort."

Lewis News
December 23, 1977

# Lewis-Cleveland Clinic to treat cancer patients

Cancer researchers have joined hands with space technologists here.

The Cleveland Clinic Foundation and NASA-Lewis said an agreement had been signed between the two institutions by which the latter's 50 million-volt cyclotron will be used in clinical trials of neutron therapy in the treatment of tumors.

The first patient has received treatment.

Dr. William S. Kiser, chairman of the Clinic's board of governors, said the program will be funded for three years by a $519,000 grant from the National Cancer Institute. The $200,000 cost of necessary modifications of the cyclotron facilities, to make them suitable for patient care, was paid by the Clinic.

Patients, who will receive the treatments at the campus-like Lewis complex, will be selected by physicians throughout the Great Lakes area in coordination with the staff of the radiation therapy department of the Cleveland Clinic. Clinic physicians will administer the treatments in coordination with each patient's referring physician. These activities are integrated in the program of the Cancer Center of Northeast Ohio, Inc., of which Cleveland Clinic is a member.

*(Continued on page 3)*

# *Cancer treatment program...*

*(Continued from page 2)*

Cleveland is the fourth area of the country where such trials are underway. Other "fast neutron" treatment centers are at M. D. Anderson Hospital and Tumor Institute, Houston, Texas; U. S. Naval Research Laboratory, Washington, D.C., and Fermi National Accelerator Laboratory, Batavia, Illinois.

The Cleveland Clinic Foundation is one of the world's largest privately-funded medical centers. Its group practice staff of 300 physicians and scientists provides specialty care for nearly 3,000 patients each day. The institution has a 1008-bed hospital, extensive outpatient facilities, a division of research and an institute for postgraduate and continuing medical education that serves approximately 2,500 physicians annually.

"Neutron therapy has shown beneficial results in the treatment of certain tumors, but it is still largely an investigative technique. We view the program as a challenging opportunity to evaluate this relatively new approach to radiation treatment," said Dr. Antonio R. Antunez, head of radiation therapy for Cleveland Clinic and medical director of the cyclotron program.

Of NASA's involvement, Dr. Bernard Lubarsky, acting director of Lewis, said: "It is always gratifying to be able to transfer space technology to the health field, and we at Lewis are particularly pleased in this case to be able to contribute to new studies of a public health problem of worldwide concern. Whatever progress we make in this team approach will be well worth the effort."

Basic steps in adapting the Lewis cyclotron to its new role included rerouting of the cyclotron beam, calibrating the instrument so as to provide exact prescribed dosage levels, and constructing a properly shielded patient treatment room together with associated facilities. The Lewis facility will allow for treatment of the patient in either a vertical or horizontal position. The unique aspect–vertical neutron beam treatment–doctors believe will make it possible to more readily treat tumors located in the thoracic or pelvic regions.

Why is neutron therapy used only in the case of carefully selected patients, and how does it differ from conventional radiation therapy?

"To be a suitable candidate for neutron therapy a patient must have a tumor that has not spread and which cannot be effectively treated by conventional procedures such as surgery, cobalt, x-ray or chemotherapy," said Dr. Antunez.

In the "fast neutron" procedure at Lewis, the physician will determine the amount of radiation the patient is to receive and enter this and other information on a keyboard terminal connected to a computer located in the cyclotron control room. The patient's exposure will be continuously monitored and automatically terminated by the computer when the proper dosage has been given. Independent circuitry will also monitor the exposure so that dosage levels can be maintained in the unlikely event of computer failure during treatment.

# Speakers' Corner

**December speakers**

**Ronald J. Schertler,** Applications Division, December 1, 1977, Rotary Club of Lorain, Lorain, Ohio.

**Marshall W. Dietrich,** Solar Energy Division, December 5, 1977. Willoughby Rotary Club, Willoughby, Ohio.

**Harvey H. Schwartz,** Transportation Division, December 14, 1977, Electric Vehicle Association, Cleveland, Ohio.

**Jarman G. Kennard,** Solar Energy Division, December 16, 1977, Westpark Radiops, North Olmsted, Ohio.

**William J. Waters,** Materials & Structures Division, December 20, 1977, Hillside Junior High School, Seven Hills, Ohio.

# Administration

**EDITOR'S NOTE: The following articles by Directors of Lewis' organizational units beginning on this page comprise the annual summary of major accomplishments at Lewis during the past year.**

*Calendar Year 1977, as you might expect, saw a continuation of the support services provided the Center by the Administration Directorate. The fact that we were able to do so without major problems reflects favorably on the staff and I want to thank them here for their hard work. Still each year provides its own peculiar highlights and activities. Some of these for calendar year '77 are summarized below:*

The **Office of Patent Counsel** conducted the Second Annual Inventors Awards Ceremony. NASA's Administrator has endorsed the program and expanded it to select a NASA Inventor of the Year. This individual will then be submitted as the NASA nominee in a national "Inventor of the Year" competition sponsored by the Association for the Advancement of Invention and Innovation. Among its many activities the **Office of Environmental Health** sponsored a seminar for the Northeastern Ohio Association of Science Teachers on Community and Industrial Noise. They were also involved in the review and approval of the radiation safety program for the Lewis cyclotron in the treatment of cancer patients in conjunction with the Cleveland Clinic. The **Chief Counsel's Office** was also involved in the preparatory work for this program having participated in the negotiations leading to the unique consortium agreement governing the program. Calendar year '77 also found our attorneys involved in a total of nine suits involving the Center. The **Office of Occupational Medicine** had what it characterizes as a routine year which includes over 18,000 patient visits, 434 reports of work injury and 2,562 blood pressure readings. The Lewis Blood Bank reported collections of 1,143 pints of blood. The **Plum Brook Management Office** continues to watch over the Station and play landlord to a variety of tenant agencies. Several significant decisions during the year have heightened activity in the office. NASA decided to retain in standby only SPF, HTF, B-2 and K-Site. As a result efforts are now underway to decommission the Reactor Facility, mothball the remaining facilities and excess approximately 2,000 acres of land.

**Personnel Division** – Training opportunities in communications and counseling skills were provided to 418 people. 468 center managers and supervisors have also had training in the techniques and methodology of PAR. Cooperative education efforts were bolstered by the signing of agreements with six more colleges and universities and the establishment of a pre-cooperative education program in engineering. The division was actively involved in negotiating a labor agreement with LESA and conducting ten training sessions to orient S&E supervisors on the administration of the agreement. A pre-retirement planning program was also made available to 460 Lewis employees and spouses. The appointment of a career counselor has also provided another service to employees. Approximately 36 employees have availed themselves of this service to date.

**Procurement Division** – During calendar year 1977, the Procurement Division processed approximately 18,000 Purchase Requests resulting in 15,600 contractual actions valued at $222 million.

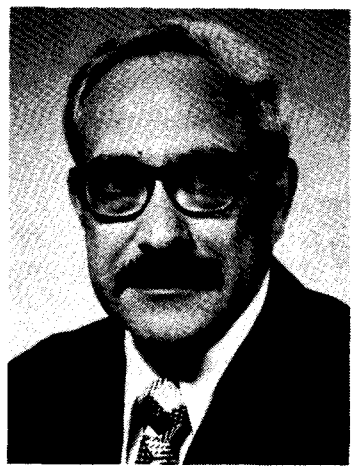
Through the cooperative efforts of Lewis personnel, the Procurement Division was successful in exceeding the Center assigned goal of $1,000,000 for 8(a) Minority Business Awards by approximately $425,000. While we did not achieve the NASA assigned goal for small business of 14.9% our overall percentage to small business of 13.7% exceeded our experience of any previous year.

During calendar year 1977, the Procurement Division initiated the first step of the Procurement Management Technology Program (PMTP) through computerization of our small purchase activity. Our locally designed system has been adopted by the NASA Office of Procurement as the model for other Centers under the PMTP Program.

**Management Services Division** – The Management Services Division continues to provide a wide variety of services to the Center, many of which must be specially expedited in order to meet extremely short deadlines.

Technical publication activity increased during 1977, processing 490 items compared with 476 in 1976. Contract Reports remained steady at a little over 200.


*Security-safety with a friendly touch.*



**WILLIAM DEY, JR., DIRECTOR**

Other types of publications (which are not included in NASA's "STAR" and "IAA" technical publications announcements) also increased and were the source of much of the "special handling" work.

Additionally the Division had improvements and accomplishments in other areas. Service in the Travel Reservation Section was improved through the installation of a computer terminal tied to the Apollo reservations system of United Airlines. Over 1200 people were relocated in four months. We normally average about 100 per month. A substantial reduction in paperwork was accomplished in the Management Analysis and Forms area and response time by the Library for requests for "STAR" items was also improved. Activity increased substantially in the following areas: Technical slide preparation increased over 21 percent (4000 plus). A substantial increase in new exhibits and support of the Visitor Information Center was also experienced. And increased activity with interagency programs for DOE, FAA, NRC and others occurred particularly in the Photographic and the Editorial Branches.

# Technology Utilization and Public Affairs

DR. WALTER T. OLSON, DIRECTOR

It was a boom year for the **Technology Utilization Office**, with more than 10,000 individual inquiries for technical information or assistance (average: 40 per day!); that's more than double the number ever before handled in a year. The handsome new journal format for *Tech Briefs* and extensive republication by others are credited for the heavy action.

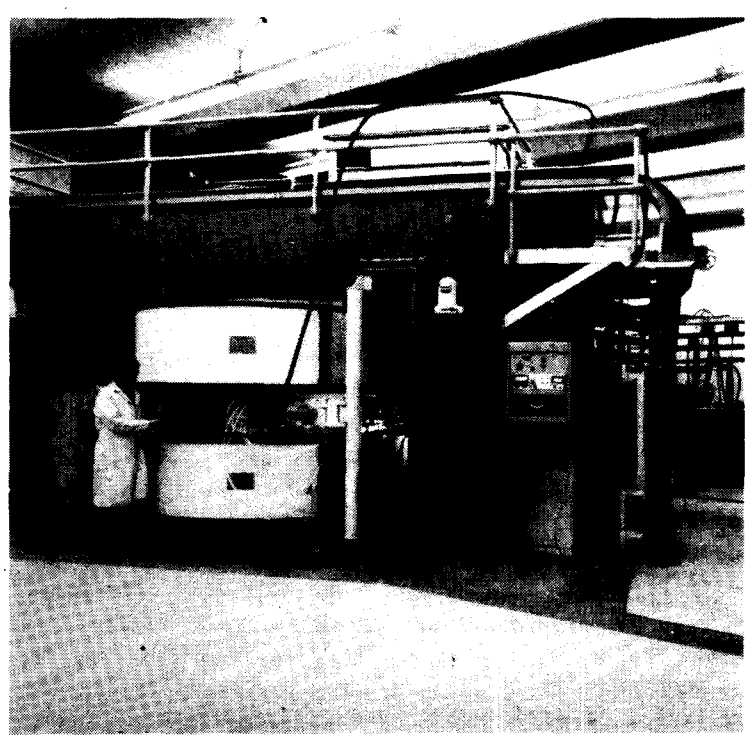
Between visits, calls, letters, and relocating their offices, T. U. engineers also prepared and submitted for publication 57 Tech Briefs and descriptions of new computer programs, completed a handsome display titled "NASA Technology is Everywhere" for Lewis' Visitor Information Center, and managed eight applications engineering projects.

Biomedical engineering was featured among these projects. Working under a grant from the National Cancer Institute, physicians from the Cleveland Clinic are treating cancer patients with a neutron beam generated by the Lewis cyclotron. A surgical tool for removing cataracts through a small incision and related intraocular pressure regulating components are undergoing field trials. Other projects include technical assistance to the Central Medical Emergency Dispatch System in the Cuyahoga County area and image enhancement of CAT scan x-rays; use of a nickel-zinc battery to improve powered wheel chair performance has been negotiated for performance this year.

Four in-house developments plus one with Hughes Aircraft Company were selected in the nationwide *IR-100* competition for the 100 most significant new technical developments of the year. These five winners put Lewis third behind giants General Electric Company and Union Carbide Corporation in 1977, and twelfth out of 500 on the all-time winners list, – far ahead of any other federal laboratory.

Cash awards for reporting a technical innovation were made to 46 Lewis staff members and 20 contractor personnel.

In **University Affairs**, the first year of Project MINE was completed. Project MINE comprises a wide variety of activities between Lewis and Tennessee State University and between Lewis and Tuskegee Institute and is aimed at helping to launch minority graduates into useful aerospace careers. The two projects so far have involved eight students on summer jobs, two transfers of equipment, a research grant, a lecture, and two visits to Lewis by 22 students and faculty.



*Cyclotron at Lewis creates a neutron beam for experimental treatment of specific cancer tumors.*

Grants were active at five minority colleges and universities where a match had been found between the grantee and his students and a Lewis technical activity.

The 14th year of the ASEE/Case Western Reserve University Lewis Summer Faculty Fellowships brought 33 faculty from 32 universities to the Center for ten weeks of participation in research and an eclectic program of lectures and other activities.

The Director of Technology Utilization and Public Affairs continued to be active in several university advisory and civic capacities in order to help tie Lewis to the broader community.

The Lewis Visitor information Center, managed by the **Educational Services Office**, neared completion, with all but one of the seven subject galleries finished, or nearly so. In use during construction, the VIC had 60 percent increase in traffic over 1976. In the VIC Resource Room, 908 teachers copied 8,734 slides, 54 audio tapes, and 50 video tapes and gathered thousands of flyers for classroom use. The Lakewood and Parma school systems developed astronomy and energy teaching units drawing substantially on Lewis information and visual aids.

A Spacemobile is a van plus lecturer with enough visual aids for a variety of school programs. The three Spacemobiles tour Lewis' six-state area (Ohio, Michigan, Indiana, Illinois, Minnesota, Wisconsin). Spacemobile personnel presented about twice as many workshops for teachers as in 1976, participated in summer workshops, including Lewis' 8th Annual Aerospace Workshop for Teachers, with college credit offered by Baldwin Wallace College and by Kent State University. The Spacemobiles also conducted two weeks of programs at Chicago's Museum of Science and Industry. While there, they participated with members of the museum staff in "News of the Air", a question and answer radio program; the program was subsequently distributed to 800 *Voice of America* stations.

*Voice of America* also taped discussions of NASA work by Lewis' Dr. Wojiech Rostafinski for airing to Polish-speaking people.

**Lewis Box Score – 1977**

| | Public contacts (6-state area) |
|---|---|
| Traveling exhibits (38 events) | 9,000,000 |
| Film viewing (20,763 loans) | 3,696,250 |
| Spacemobile (1193 demonstrations) | 183,878 |
| V.I.C. Visitors | 32,000 |
| Speakers' audiences (193 speeches) | 31,285 |
| Center tours (475 tours) | 22,306 |
| Mail inquiries answered | 17,577 |
| Teachers Workshops (268) | 1,995 |
| TV, Radio, Press | ——— |

Yet another highlight was the annual meeting of the Cleveland Regional Council of Science Teachers, November 4 and 5. Lewis Research Center was both host and participant; Astronaut Joseph Kirwin, M.D., was banquet speaker; attendance reached 300.

The Educational Services Office also manages film loans, answers general interest mail; supervises tours, and operates the speakers bureau; see "Box Score".

The **Public Information Office** was expanded and its capability increased with addition early in 1977 of a Public Information Officer.

One of the main thrusts of the Office during the year was to reflect the changing image of Lewis as an aerospace center of leadership to one including substantial achievements in technology transfer, such as the Center's growing role in studying and developing alternate energy forms for terrestrial applications.

Notably, sizable promotional efforts were undertaken in support of the Communications Technology Satellite, solar cell applications and wind energy devices. Considerable media attention resulted with the promise of even greater productivity in 1978.

Better ways to project the Center's current R&D involvement were investigated, and procedures were initiated to help accomplish the objective of showing Lewis as a continuing strong component in maintaining U. S. superiority in aeronautical and space propulsion.

Through exploitation of such technology transfers as new batteries from electric vehicles, the fast neutron cancer therapy program, and infrared thermography of heat-leaking rooftops in a number of cities, the Office actively sought to boost the stock of Lewis as a proponent of space technology for terrestrial purposes.

By number, some 75 press releases were produced and distributed during the year to local, regional and national media; this effort was augmented by Headquarters corelease of most of this material to their extensive news media lists. Nearly 400 individual media requests or call-generated media responses were recorded at year end, each of them resulting in specific placement of Lewis news on the air or in print of local, regional or national character.

In spite of proposed cutbacks in manpower and program money, efforts to reassess Lewis' new place in the scheme of things and to find new opportunities to tell the Lewis story are succeeding.

Among other noteworthy items in 1977:

- PIO detailed a staffer fulltime to the Combined Federal Campaign for three months, sharing in the achievement of a record-breaking $750,000 raised from among Greater Cleveland federal employees.
- Lewis traveling exhibits were provided for 30 events in our six-state area with additional displays supplied for eight continuing exhibitions.
- The *Lewis News* distributed 5000 copies on a bi-weekly basis to the staff, Headquarters, other NASA installations, federal government agencies, and approximately 1000 Lewis "alumni."

In sum: a busy and productive year for this Directorate.

# Faculty Fellows-Lewis: Mutual admiration society

Twenty-four science and engineering professors representing colleges across the nation spent the summer here as Faculty Fellows to sharpen their technical skills, and, at the same time, lend their expertise to Lewis' overall mission.

The program started in June, and all too soon, ends this month. All the Faculty Fellows hold Ph.D.'s.

**SUSAN M. BENFORD, HIRAM COLLEGE.** She performed experiments on magnetic and thermal properties of rare earth ferromagnetic materials in support of the magnetic refrigeration program. The work was in the Physical Science Division.

**RICHARD J. BODONYI, INDIANA-PURDUE UNIVERSITY at INDIANAPOLIS.** Bodonyi was asked to modify an existing computer code for two-dimensional boundary layers on compressor blades. The modification permits continuous calculation of the flow even when flow separation is encountered. He was assigned to the Fluid System Components Division.

**LARRY E. CAMPBELL, HOBART & WILLIAM SMITH COLLEGE.** Using cyclotron-produced radioisotopes, he studied the feasibility of a gamma ray laser. He was assigned to the Physical Science Division.

**WAYNE Y. CHEN, PURDUE UNIVERSITY.** Dr. Chen determined the effects of aging iron-base superalloys in a hydrogen environment. Alloys selected were based on their potential application in improved Stirling engines. He was assigned to the Materials and Structures Division.

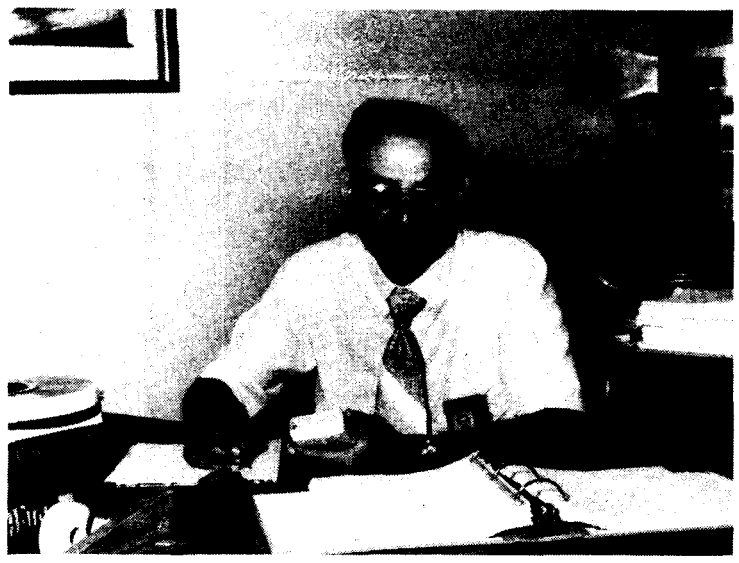
**CHIA-CHING FENG, TRENTON STATE COLLEGE.** His efforts involved developing an analytical model of the flashback phenomenon in order to successfully integrate the concept of lean premixed/prevaporized combustion into a practical combustion system.

*Susan Benford and Gerald V. Brown fill tank with liquid nitrogen for low temperature studies.*

**RAMA S. R. GORLA, CLEVELAND STATE UNIVERSITY.** Dr. Gorla has conducted load, speed and temperature tests to determine the formation and thickness of elasthydrodynamic films in a full scale ball bearing. He was with the Fluid System Components Division.

**MAHESH INDER GREYWALL, WICHITA STATE UNIVERSITY.** His project was a theoretical study of the electrical conductivity of hydrogen/oxygen combustion gas containing small amounts of alkali metal and flowing in the presence of an electrical field. The results will assist the NASA-Lewis MHD power generation program. Dr. Greywall worked in the Physical Science Division.

**CHARLES E. HAWKINS, SPRING ARBOR COLLEGE.** He analyzed optical spectroscopic emissions from a 30 cm. electrical thruster to characterize the plasma jet and to help determine thruster life. He also analyzed the accelerator grid design with a view to improving the power efficiency of the thruster. He was in the Space Power and Propulsion Division.



*Mahesh I. Greywall computes method for solving channel and diffuser problems.*

**ALLEN M. HERMANN, TULANE UNIVERSITY.** Dr. Hermann investigated the effects of electron irradiation on the internal physics and the performance characteristics of silicon solar cells. These and other activities by Dr. Hermann were conducted in the Solar and Electrochemistry Division.

**WARREN E. HOFFMAN, INDIANA INSTITUTE OF TECHNOLOGY.** The major thrust of Hoffman's work in the Materials & Structures Division included determining the properties of polymers and composite materials made from them as influenced by the chemistry of the starting materials.

**RUSSEL K. HOTZLER, QUEENSBOROUGH COMMUNITY COLLEGE.** He studied certain behavior of oxide dispersion strengthened nickel-base superalloys while assigned to the Materials and Structures Division.

**DANNY P. HWANG, INDIANA TECHNICAL INSTITUTE.** Dr. Hwang's work dealt with the analysis of the aerodynamics of V/STOL engine inlets, including calculating potential flow static pressure distribution, streamlines, boundary layer growth and separation and boundary layer control. He was assigned to the Wind Tunnel and Flight Division.

**FRANCIS E. KENNEDY, JR., DARTMOUTH COLLEGE.** His work in the Fluid System Components Division was directed at the problem of gas-path seals at the tips of compressor and turbine blades in aircraft engines; a specific concern is the energetics and wear of the seal materials.

**ALAN B. KUPER, CASE WESTERN RESERVE UNIVERSITY.** His project was to fabricate solar cells from large-grain, polycrystalline silicon and to measure the photo-response properties of grain boundaries. Research was performed in Solar and Electrochemistry Division.

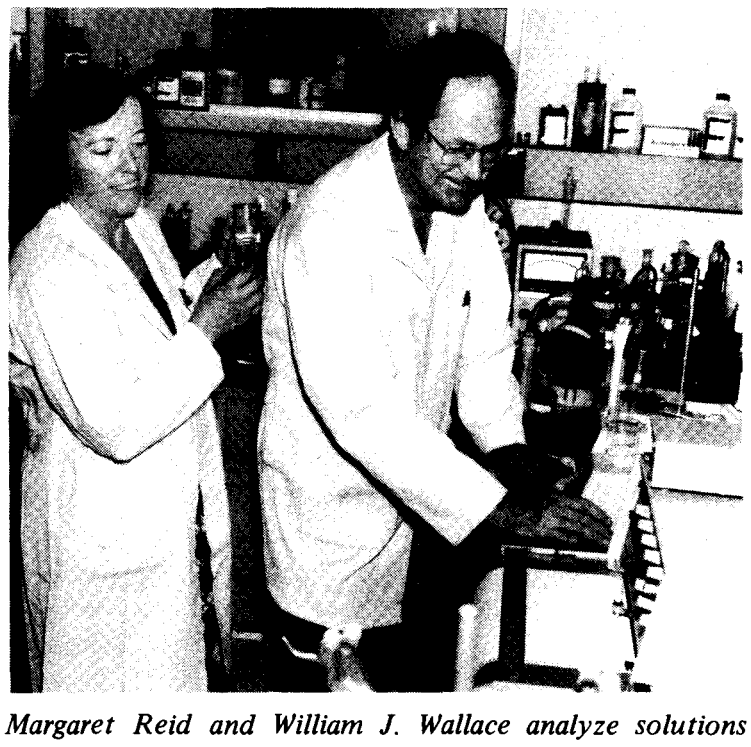
**JOHN R. LUOMA, CLEVELAND STATE UNIVERSITY.** Luoma devised models from which to derive and solve equations for the diffusion of zincate ion in an alkaline half cell under various conditions. The results will be interpreted in terms of the transition of electro-deposited zinc. This work in the Materials and Structures Division pertains to improved electric batteries.

**RALPH D. MAIER, CASE WESTERN RESERVE UNIVERSITY.** Dr. Maier studied microstructured stability, coating integrity and interactions between thermal barrier coating systems and solidified eutectic superalloys in order to find out why thermal barriers can function effectively on the alloy system. The program of developing ceramic thermal barriers for metals is in the Materials and Structures Division.

**JOHN R. McCLENON, SWEETBRIAR COLLEGE.** He supplemented contractual work on an improved hydrogen fuel cell for the Solar Electrochemistry Division. Both enhanced reactivity with oxygen and cost reductions are sought.

**CHARLES R. McCONNELL, MIDWEST COLLEGE OF ENGINEERING.** Dr. McConnell, working in the Computer Sciences Division, simplified methods of calculating time-until-failure probablity distributions where there are competing causes of failure of a test item.

Photos by Don Huebler



*Margaret Reid and William J. Wallace analyze solutions for redox flow cell project.*

*Vernon D. Neff (left) and Robert E. Post check a five-cell prototype redox flow stack.*

# Side effects normal in neutron cancer care

By Elizabeth Price

Early results of treating cancer patients experimentally using an atom smasher at NASA Lewis Research Center indicate side effects are no worse than with more traditional treatment, says Dr. Antonio R. Antunez of Cleveland Clinic Hospital.

However, it is still too soon to tell if treating patients with beams of neutrons, produced by NASA's cyclotron, will be superior to X-ray or cobalt therapy, he said.

NASA scientists and the hospital's doctors have been working together since December on the experiment, one of four such projects in the nation. They have treated nearly 100 patients.

All of the patients have localized tumors that are inoperable or that have not responded to other forms of cancer therapy. Tumors in the brain and pancreas are the most commonly treated, but tumors of the bladder and prostate also are treated, said Antunez, director of radiation therapy at the hospital and medical director of the cyclotron project.

Neutron therapy costs the patients nothing, said Antunez. NASA, the hospital and the National Cancer Institute are financing the experiment, which will last at least three years.

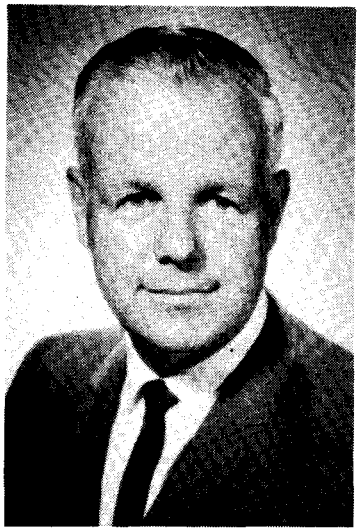
Purpose of the experiment is to find out if bombarding cancer tumors with neutrons will be more effective than using X rays or cobalt, Antunez said.

"I'm very enthusiastic, but I refuse to say that I am optimistic," said Antunez. "Neutron therapy today is in the cradle. It's in its infancy. We're where we were with X rays in the 1920s."

In the NASA experiment, patients are treated twice a week with neutrons at the Lewis Research Center and three times a week with X rays at the hospital for six weeks. In England, similar experiments have used neutron therapy exclusively, but side effects such as nausea, diarrhea and skin reaction have been worse, said Antunez.

In the future, he said, patients might be treated experimentally with X rays and neutrons spaced only by minutes, rather than days. Some laboratory experiments on animals have shown that this type of mixture might be more effective, he said.

# Technical Services



**JAMES F. CONNORS, DIRECTOR**

The year 1978 was one of great accomplishment for Lewis technical support organization. However, the gains were also achieved in the face of increasingly difficult circumstances; i.e., a constantly decreasing complement and a centerwide skill-mix problem. Technical Services has absorbed 75% of the impact of the recent 108-position reduction at Lewis without a commensurate decrease in Center program and now, during the one-for-two hiring freeze, is continuing to experience heavy attrition at the end of the year. This trend has to be reversed and the complement and the program rebalanced! Three excellent new division chiefs (Walt Russell, George Tunder and Bill Brown) have been installed during the course of the year. The organization is strong and productive in carrying out its programmatic support role.

We can only point herein to a few selected projects with major accomplishments in which we feel a very real sense of partnership with the research and technology professionals. In the Wind Energy areas, a tremendously responsive effort was expended in the repair of the Mod-OA blades for the Clayton, NM, wind turbine, the fabrication of the soft-tower structure for the Plum Brook machine and the fabrication of the low-cost (telephone pole-plywood-plastics) experimental blades. In other Energy areas, the open-cycle MHD facility attained its design of 87-KW output. Two remote village solar energy power systems were prepared for the Schuchuli Indian village in Arizona and a tribal installation in the Upper Volta, Africa. The Chrysler turbine engine test facility (CE-28) was brought to operational status.

For aeronautics, we point to the 804 hours of Icing Research Tunnel operations and the 240 hours of turboprop experimentation in the 8 X 6 SWT. The Quiet Clean Short-haul Experimental Engine (QCSEE) over-the-wing tests were completed and results presented at a fall Lewis Research Center conference.

In the Space arena, CTS (Communications Technology Satellite) completed three years of highly successful operations. The FM/power processor unit and the bimod truss structure for the 30-cm. Ion Thruster were excellent fabrication jobs.

In the Applications areas, 117 patients have undergone neutron cancer therapy treatments in the Lewis cyclotron. This was in conjunction with the Cleveland Clinic Foundation. The C-131 airplane has the remote scanning research equipment installed and is now operational.

We can't look back in 1978 without recognizing

*(Continued on page 10)*

# TECHNOLOGY UTILIZATION & PUBLIC AFFAIRS

*Astronaut Judy Resnik helped celebration of Apollo 11 anniversary. Her interest in Lewis stimulated a later visit by the most recent astronaut group as part of their training.*

*Highlights from the* **Technology Utilization Office** *included culmination of several efforts to increase the uses of aerospace technology for the benefit of our nation's people:*

- Neutron beam treatment of cancer. Requisite modifications to the cyclotron here by Lewis staff have permitted physicians from the Cleveland Clinic to radiate tumors with neutron beams on a regular and reliable basis. After more than 4400 treatments to 219 patients during the last two years, the project, including operation of the cyclotron, is now being transferred to the Cleveland Clinic with continuing support from HEW's National Cancer Institute.
- Development of instruments for ophthalmic surgery. HEW's National Eye Institute has assumed full responsibility for completing the development and testing of both a cataract surgery instrument and an intraocular pressure-controlling instrument pioneered by Lewis's staff and associated surgeons. The cataract instrument may permit routine removal of cataracts through a small incision and thus eliminate extended hospitalization.
- Emergency medical and police communications systems for Akron. Systems specified by Lewis are in successful use.
- Bird/powerline impact rate prediction. A prototype low-power laser system designed, built and tested at Lewis was installed at a site in Minnesota for field testing by the U.S. Fish and Wildlife Service.
- Voice output solar energy reporter. Systems designed and built earlier at Lewis were put into public service or on display at five other NASA Centers.

Fifteen more applications projects are continuing.

The Technology Utilization Office promoted three winners in the IR-100 competition for the 100 most significant technical products of the year. Lewis stands eighth among more than 550 organizations on the all-time winners' list.

A series of seminars sponsored by the American Institute of Aeronautics and Astronautics at NASA Centers is serving to intro duce top technical executives from Fortune 500 industries to aerospace technology. The Technology Utilization Office provided professional and logistic support to seminars at Goddard, Lewis, Langley and Marshall.

Also, this office published 54 items, presented 74 awards to in-house and contractor innovators, made 28 speeches, generated a "Space Spinoff for Sportsmen" exhibit, and handled 2800 technical inquiries, 575 of them on the REDOX energy storage system.

Highlights in the Center's public affairs activities included:

- Groundbreaking ceremonies for the Research Analysis Center.
- Dedication events for wind turbines at Block Island, R.I., and Boone, N.C.
- Celebration of the 10th Anniversary of Apollo 11; included Astronaut Resnik visit.
- Annual Teachers' Workshop, "The Sky as Your Classroom"; attended by 50 teachers for two weeks.
- Deluge of queries and radio, TV and press interviews from Skylab re-entry.
- Visit of Senator John Glenn.

*The Visitor Information Center continued to grow as a notable attraction in the Cleveland area. Over 100,000 persons visited in 1979. It's open daily, including Sunday afternoons.*

- Visit of 100 Edison Scholars (high school).
- Sponsorship of several youth programs featuring Communications Technology Satellite (CTS).
- Exhibits at 50th National Air Races.
- Initiation of new video tape service to educational and public service television.
- Initiation of "HEAD—LINES," a quarterly report of Lewis public affairs activities.

The **Public Information Office** issued 71 news releases during 1979. The biggest response of the print media was to the turn-on of the wind turbine at Boone, NC; results were at least 8900 column inches in 597 publications with more than 50 million circulation. Thirty-five newspeople came to July 18 press conference for astronaut Judy Resnik. Other big news generators were the magnetic heat pump, REDOX energy storage, Wind Turbine conference, Block Island wind turbine, "Aeropropulsion 79" conference, 50th Atlas-Centaur launch, the Visitor Information Center, young students on CTS, Nasvytis multiroller traction drive, advanced automotive gas turbine engine contracts, coal gasification and cogeneration study project.

Radio and television interviews with Lewis officials were at a high level; some were initiated by the PIO and included interviews with Dr. McCarthy, Senator Glenn, astronaut Resnik, and Visitor Information Center principals. Others resulted from media interest in subjects such as energy and Skylab's re-entry.

**DR. WALTER T. OLSON**
**DIRECTOR**

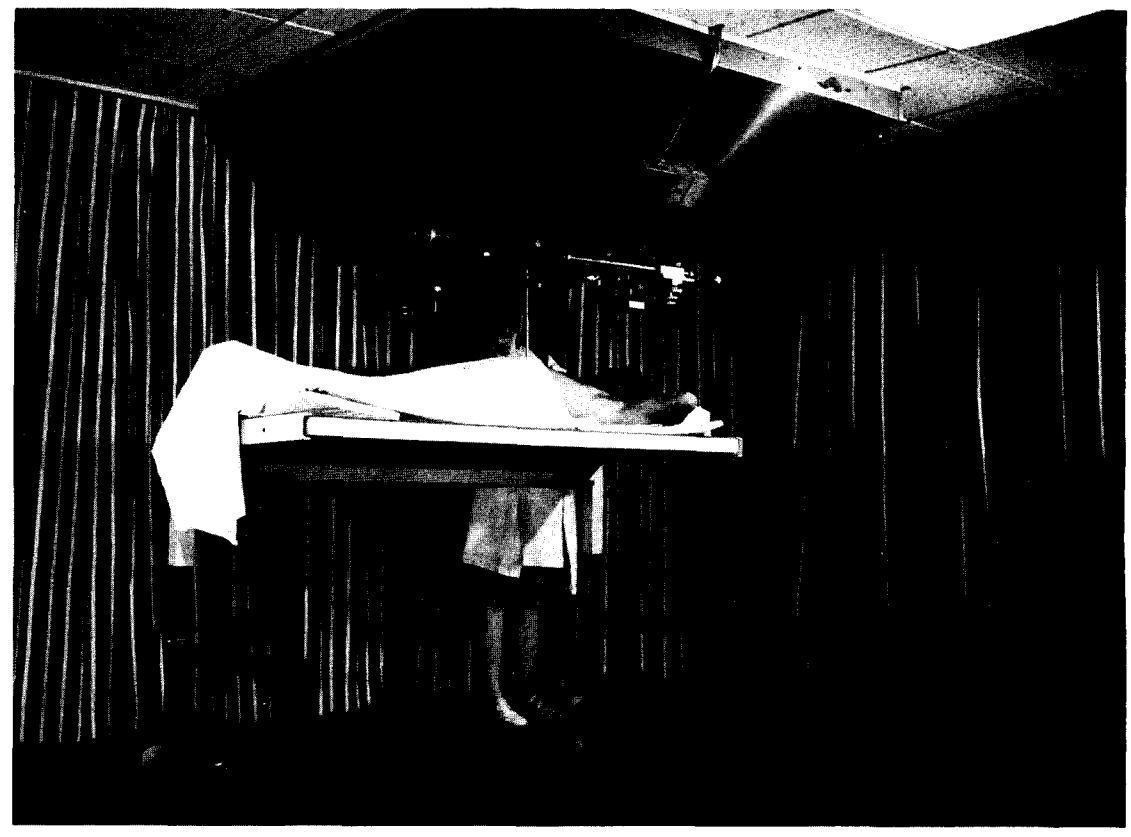
Increased effort was planned and initiated to improve coverage of Lewis's capabilities and achievements by technical and professional journals.

Lewis's traveling exhibits managed by this office were on display in 53 places for an estimated 6 million viewers.

Necessarily, much of the time and energy of the staff of the Public Information Office also went to the routines of responding to thousands of telephone calls, hundreds of mail inquiries and dozens of visits—all from media personnel, advertisers and promoters, and the general public seeking information, films, pictures, or a service of some kind.

And, bi-weekly, 5500 copies of the Lewis News went to our staff and alumni, headquarters, other NASA centers, selected federal agencies and local media.

The **Educational Services Office** offers a videotape service to educational and public television that has grown rapidly. An estimated audience of over 70 million people viewed Lewis videotapes of NASA films via the WESTAR satellite.



*Both horizontal and vertical neutron beams generated by cyclotron make cancer-treatment facility at Lewis unique in the world.*

Fifty programs taped from films are now available. The office also created videotaped programs, "Mr. Mills Reports on Jupiter Flyby" and "NASA-Lewis presents: Pioneer Saturn Encounter," that are used nationally. The Saturn program was the first to bring new scientific findings to a classroom promptly via satellite (WESTAR).

That office also sponsored a number of special events: an aerospace workshop with college credit, a community program involving 8500 people in Lansing, Michigan, briefings at Lewis for courses in astronautics and in energy from Case Western Reserve University, a program for Library Day in Strongsville, Ohio, a tour for Edison scholars, and interchanges for young students via the

(*Continued on page 6*)

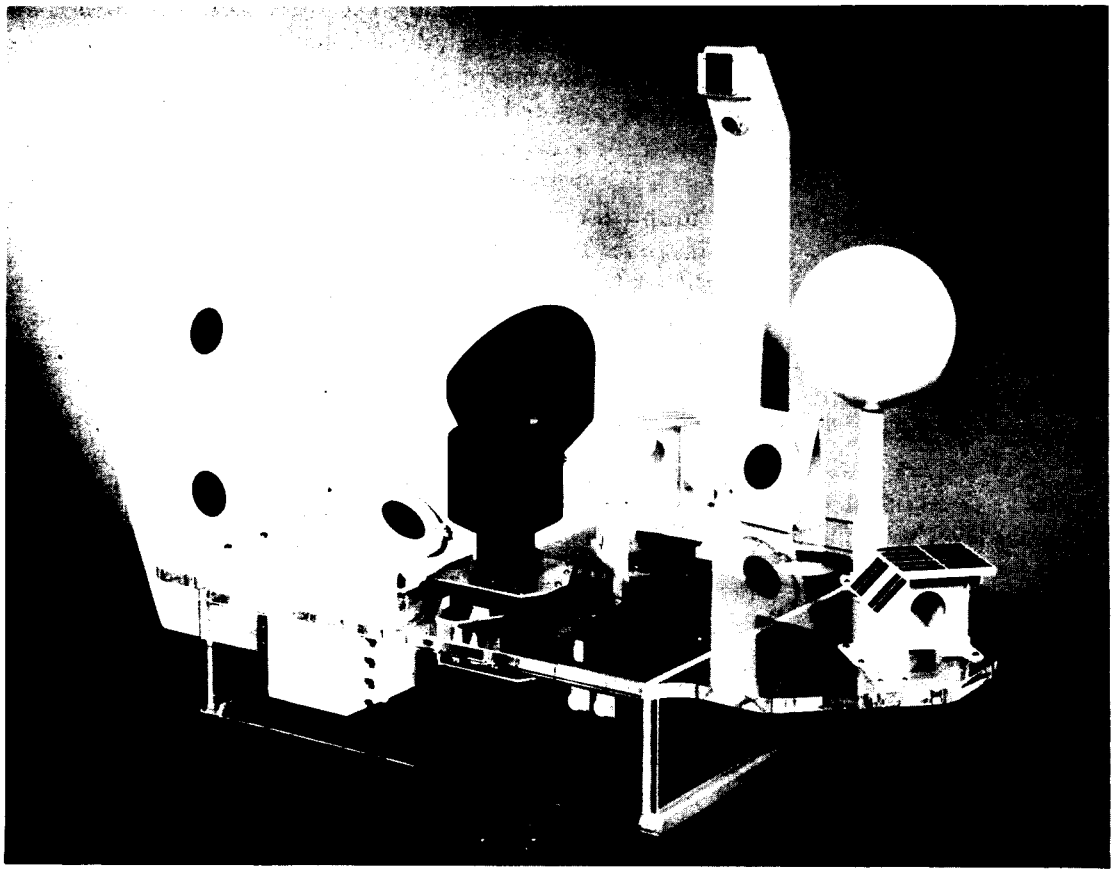
# SPACE SYSTEMS & TECHNOLOGY...

*(Continued from page 7)*
structures and high voltage systems. Lewis was selected to lead the multi-center investigation in technology to control charged-particle interactions in a seven-year joint Air Force-NASA program.

The application of our technical expertise to a wide variety of problems is part of our charter as a technology center. Our technology capability was applied to two widely different but very important areas in 1979.

At the request of John Yardley, Associate Administrator for Space Transportation Systems, Lewis formed the Shuttle Main Propulsion System Assessment Team to make an in-depth review to enhance confidence that the propulsion system will perform as required. Twelve Lewis engineers with additional NASA and contractor support performed this year-long task, for which they received a NASA group achievement award. The management of the effort was the responsibility of Howard Douglass, with members from the Space Systems and Technology Directorate, Launch Vehicles Directorate, Energy, Aeronautics, Technical Services and R&QA, truly a team effort.

A second benchmark effort was a joint program with the Cleveland Clinic Foundation in the use of the Lewis cyclotron in the treatment of cancer patients. This year the Lewis cyclotron has treated about 150 patients' cancerous tumors with fast neutrons generated by bombardment of beryllium with 25 MeV deuterons. The initial response of tumors to the radiation is considered by the Cleveland Clinic radiotherapists to be good. Although insufficient time has elapsed to proclaim any cures, a peer group of the National Cancer Institute has recommended that the Cleveland Clinic Foundation be funded for three to five years of additional cancer patient treatment.



*Shown is a model of an IAPS module.*

It is clear that our research and technology development for space are important for both space and terrestial applications, and that technology resource expenditures are yielding important contributions to our society.

# *Meet Lewis Speakers*

BY NAZHA 'NICKIE' FADIL

"I am a member of the Lewis Speakers Bureau because it provides an excellent opportunity to talk with people and I think both they and I benefit. I try to give them a balanced view of what the situation is in areas like nuclear power," commented Dr. James W. Blue, head of the Radiation Applications Office of the Physics and Electronics Division.

DR. JAMES W. BLUE

Jim's talks cover the Lewis cyclotron and its use in cancer therapy and the broad public interest topic of energy resources. On cancer everyone seems to want to know about "curing" cancer. Jim clearly explains that if a patient is treated for the disease and is symptom-free for five years, then doctors consider the patient "cured."

On energy he emphasizes that we need to use fuels that avoid dependence on foreign oil. He explains work being done in this area is progressing. He finds these subjects popular with the public.

Jim's audiences are high school and college students and many organizations. He has participated in debates including one at the University of Minnesota on whether we should have nuclear power. Herb Kamm, editor of the Cleveland Press, has interviewed Jim, and he has appeared on TV and radio.

# Center happenings

### MURIEL'S PARTY

Muriel Eian, supervisor in the DATA Analysis Production Control Office of the Computer Services Division, retired August 28 after more than 36 years of service.

A retirement dinner for Muriel is planned for Thursday, September 25 at 7 p.m. at the Brown Derby near Westgate.

For reservations or further information, contact Vi Minchak or Linda Schuller, PAX 5250 or PBX 6660.

### CHORAL GROUP

The Lewis Choral Group will begin its 14th season of music and fellowship on Thursday, September 18. The Lewis singers will entertain with a variety of music, appearances at the Lewis Children's Christmas Party and other affairs. The chorus membership consists of men and women, Lewis employees, retirees, and family members. There are no auditions. Just come to a meeting and become one of the singers. The Lewis Choral Group meets every Thursday from 5:00 to 6:15 PM in the DEB Cafeteria. For questions, call Bob Friedman, PAX 4169.

## Cyclotron Visitors

*A delegation from the National Cancer Institute, the Cleveland Clinic and Lewis inspected the cyclotron at Lewis on September 4. The NCI is considering a five-year grant proposal on neutron therapy to the Cleveland Clinic. Lewis has agreed to make the cyclotron fully available to the Clinic. The Clinic, in turn, will assume full operating responsibility.*

*Also included in the delegation were scientists and medical doctors from hospitals and universities throughout the country.* (Don Huebler photo)

# SPACE. . .

*This photo of Ganymede, a satellite slightly larger than the planet Mercury, was made by Voyager 1. Voyager 1 was launched by a Lewis-managed Atlas/Centaur vehicle.*

*(continued from page 8)*

ion thrusters were simplified with consequent reductions in parts and weight and increase in reliability.

Electric Propulsion: The 30-cm Ion Thruster Technology Readiness Program team was recognized by the Awareness Committee for the successful completion of the six-year technology readiness/transfer effort. All components have been successfully developed and tested and the engine system interfaces defined. The data obtained was turned over to MSFC for their system development work and a government/industry briefing was given at Lewis in November 1980.

Major advances were made in extending the life of critical thruster components and a program using inert gas propellants for ion thrusters made good progress.

New propulsion concepts continue under investigation. The newest start is evaluation of the rail gun propulsion concept.

Biomedical ion beam applications research technology transfer took a major step forward with the establishment of the Biomedical Center of Excellence at Case Western Reserve University.

Space Experiments: Basic combustion research in space aboard the Spacelab payload is supported with the conceptual design of a combustion facility and supporting experiment definition/evaluation work. Lewis has also been given management responsibility for the NASA-wide Cryogenic Fluid Management (CFM) Program which involves two space experiment facilities; the CFM Facility and Two-Phase Fluid Research Facility. Tests planned will help develop the technology of low gravity cryogenic propellant handling - a necessity for the on-orbit refueling of spacecraft.

Design and development of the Plasma Interaction Experiment (PIX) is proceeding. PIX, which will evaluate solar array scaling effects on plasma interactions, will fly piggy-back on the Infrared Astronomical Satellite (IRAS) in mid-1982.

**Communications and Applications Division**

The ability of our nation to continue to enjoy adequate and inexpensive communication services depends on finding an early solution to the problem of dwindling unused space in the allocated radio spectrum and the geosynchronous orbit. Fortunately, expansion of capacity appears possible through the use of the 30/20 GHz (Ka) band.

The opening of this new band is presently beyond the risk capability of the U.S. communications industry and, as a result, a major government decision was made at the Presidential level to have NASA sponsor the technology to permit a spectrum conservative and cost-competitive utilization of the Ka Communications Band.

During 1980, Lewis, as NASA's lead center for communications, began the process of implementing NASA's communications satellite research and development program in the 30/20 GHz band. This activity followed significant efforts in 1979 to define and scope the overall program.

During 1980, Lewis initiated, via twelve contracts totaling more than $30 million, a U.S. industrial program to generate the technology advances that are essential for 30/20 GHz satellite systems. This program will verify technology feasibility by proof-of-concept model testing in the laboratory.

The key technologies being developed are in the areas of multiple spot beam antennas; 75 watt Traveling Wave Tube, 20 watt Impatt and 8 watt GaAs FET transmitters; switch matrices; baseband processors; and low noise receivers. Concurrent with this technology development, Lewis worked with the U.S. system suppliers and carriers and conducted studies to define a wide range of alternative satellite system concepts that can demonstrate both 30/20 GHz technology readiness and service capabilities.

Based on this activity, Lewis will prepare during 1981 for the initiation of a demonstration program starting in 1983. Approval of this new start proposal will result in the establishment of a major flight project at Lewis.

In addition to the 30/20 GHz program, NASA Lewis is conducting a feasibility assessment of a satellite mobile communications system for use in the United States. This effort is in concert with a Canadian government team examining this same satellite application for use in Canada.

Over the next year, independent but coordinated studies will be conducted by NASA and Canada's Department of Communications to further examine the technical, economic, institutional and regulatory issues associated with a joint program as well as with future commercial mobile-satellite systems.

Base Research and Technology efforts to support satellite communications has also been enhanced during 1980 with a focused development effort on traveling wave tube amplifiers, solid state amplifiers and spacecraft antenna technology.

**Launch Vehicles Division**

The Atlas/Centaur launch vehicle program continued to accumulate program "firsts" during the calendar year 1980.

On October 30, 1980, AC-57 launched the fourth in a series of five FLTSATCOM missions, a communications satellite for the U.S. Navy, U.S. Air Force, and the Department of Defense. AC-57 was the first flight to use a newly-developed magnetic core memory in the Centaur digital computer unit.

In addition, AC-57 marked the first operational use of a software program, called Redline Monitor, that utilizes the launch checkout computer to automatically monitor the final stages of the vehicle systems checkout from T-90 minutes to lift-off.

As of this writing, AC-54 is scheduled to be launched on December 4, 1980. This flight will be the first INTELSAT V spacecraft launched for INTELSAT. In order to meet the spacecraft weight demands for this mission, several performance improvements which increased payload capability in excess of 300 pounds will be flown for the first time on this Atlas/Centaur vehicle, including earlier jettison of the nose fairing and uprated Centaur engine thrust from 15,000 pounds each to 16,500 pounds each.

In addition to the launches of AC-57 and AC-54 this year, AC-49 successfully launched the third FLTSATCOM spacecraft on January 17, 1980.

In the fall of this year INTELSAT selected the Atlas/Centaur vehicle to launch four INTELSAT V-A spacecraft in the 1982-1984 time period.

In order to meet the spacecraft weight requirements for these missions, several major design changes are being implemented to further increase the Atlas/Centaur payload capability by approximately 400 pounds.

This major engineering design activity coupled with the ambitious Atlas/Centaur launch schedule (seven launches) and coupled with the renewed interest in the use of the Centaur as an upper stage in the Space Transportation System for NASA planetary missions has all the prospects of a very busy and exciting year in 1981 for the Launch Vehicles Division.

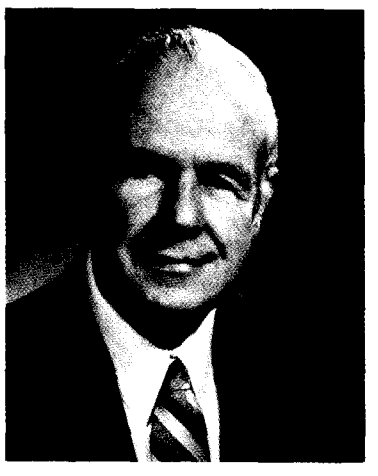
# TECHNICAL SERVICES

From the standpoint of overall plant operations, the year 1980 saw Technical Services providing a very active and aggressive technical support effort in implementing a wide array of Lewis in-house programmatic and institutional activities. With a strong integrated management approach, the Center's support programs in aeronautical propulsion and energy conversion were marked by quality performance in related skilled trades/crafts and by teamwork.

An important concomitant was effective personnel communication! In addition to the variety of AWARENESS programs, prime vehicles of communication were the Technical Services Research Support meetings with division chiefs, the Building Manager Conference series, and Technical Services' "Happy Hour" with the Center Director.

Herein, only a few of the *support program* highlights can be addressed. The High Pressure Facility (HPF) assigned top priority at Lewis by the Director was the focus of a major support effort; however, during the year it incurred more than its share of

*(continued on page 10)*



**JAMES F. CONNORS, DIRECTOR**

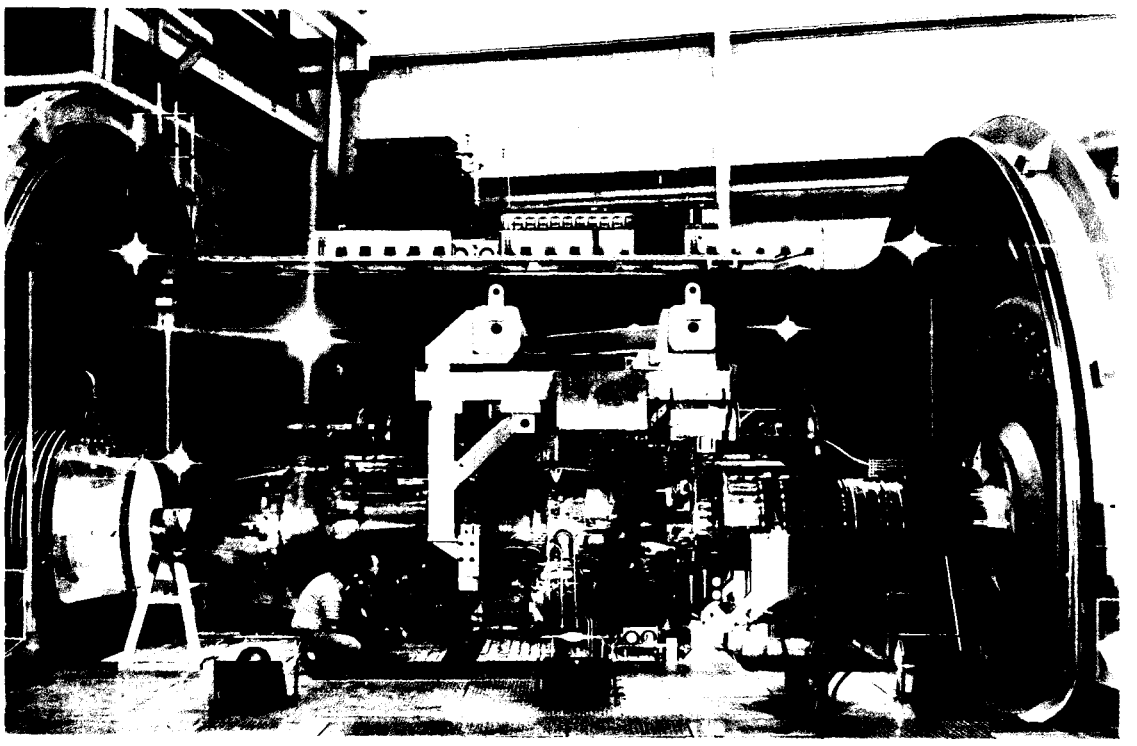
# TECHNICAL SERVICES. . .

*(continued from page 9)*
developmental problems including the major failure of no. 2 compressor.

The cyclotron has now provided neutron therapy to 318 terminal cancer patients with 6150 individual irradiations. New rigs coming into operational status this past year include the nine-blade flutter rig, the electric-vehicle road load simulator, the AVL gasoline engine, the Re-1000 Stirling engine and the single-cylinder diesel engine with exhaust gas dilution tunnel in ERB.

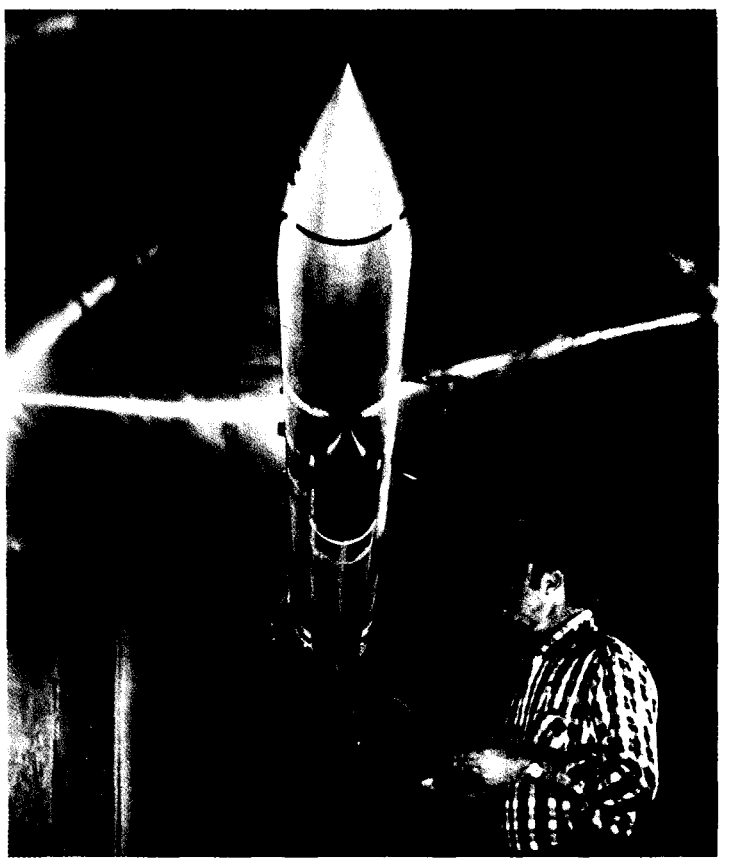
The Center's electric power consumption was up to 166,000 MWH this year, in spite of intensive energy conservation efforts, and reflects a good operational year for Lewis' major technical facilities. The 10x10-foot Supersonic Wind Tunnel ran 223 hours with research programs on a solid fuel ram jet, VTOL tandem fan, sonabouy decelerator, and a supersonic cruise inlet.

PSL 3-4 was operated 307 hours with a TF-34 engine with exhaust gas mixer and in inlet air distortion tests, the F-100 engine in fan flutter studies and the GE YJ101 engine with augmented deflector nozzle. The 8x6-foot tunnel ran 295 hours with several advanced turboprop configurations and employing a laser doppler velocimeter, while the 9x15-foot tunnel ran 92 hours with V/STOL inlets and blowing inlet bleed. Lewis' most prolific operating facility was the Icing Research Tunnel, which was run 892 hours in a variety of 16 different icing studies.



*F-100 engine, fan flutter test in PSL-4.*

*Supersonic cruise inlet in 10x10-ft. supersonic wind tunnel.*



*Solid-fuel ram jet cruise missile in 10x10-ft. supersonic wind tunnel.*

Lewis aircraft flew a total of 832 hours and the newly acquired Learjet (with an ocean color scanner for lake pollution studies) became operational in September.

*In the institutional arena*, support services contracting has been expanded significantly to include Instrumentation Acceptance Testing, Building Maintenance, Electrical Substation and Heating/Ventilating/Air Conditioning (HVAC) functions. All Cadde data systems have been replaced; with 19 new Escort data systems, installed in 1980, there are 52 now in use at the Center. The No. 1 Cooling Tower has been undergoing major maintenance/repairs.

With the acquisition of the Q-1 microcomputer/word processor system, the TSCO business center is now in operation. A computer terminal tying into the IBM-370 has also been added.

For Technical Services, manpower planning and the displaying of support personnel deployment against R&T programs have top priority in the development of new reporting systems.

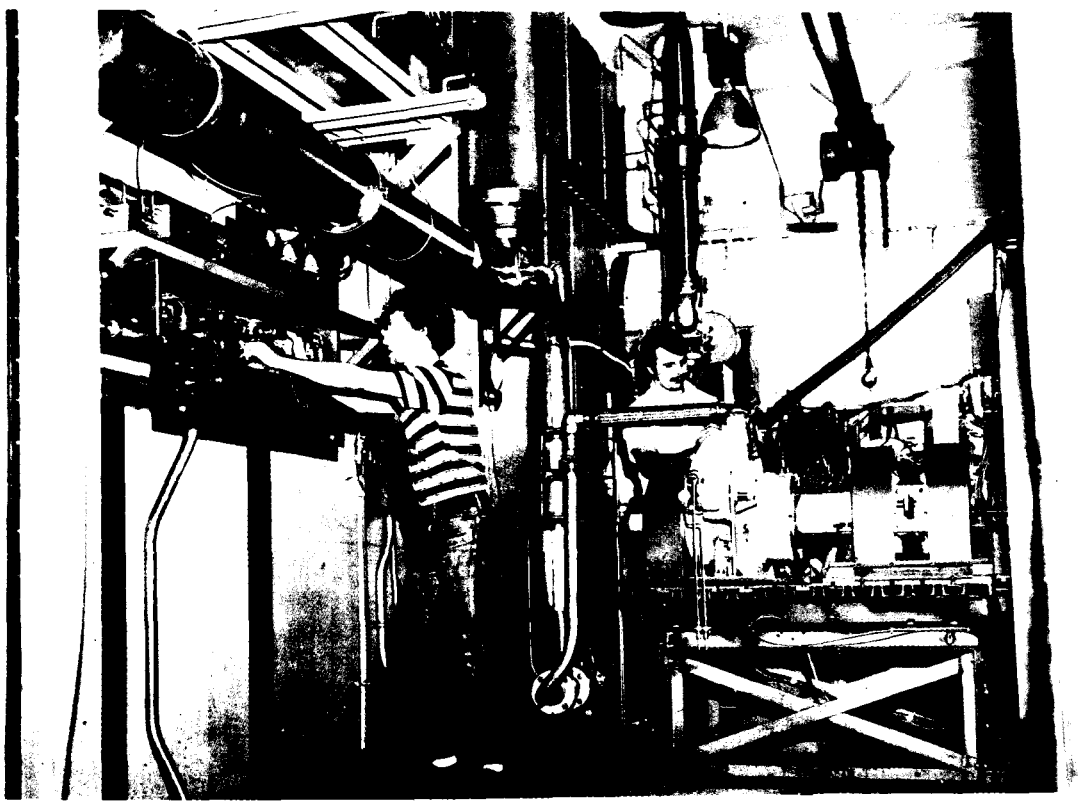
In our Electronic Systems Training Facility in IRL, 96 technicians and engineers have been trained by Technical Services in microprocessors, microcomputers and the PDP-11 minicomputer in 1980. The Headquarters property management audit this year has reflected very well on the quality of Lewis Supply and Equipment operations.

As always, *safety* is a most important facet of Technical Services operations! One most notable accomplishment is the superb training of over 600 Lewis personnel (including the senior management staff and their spouses) in cardiovascular pulmonary resuscitation (CPR) and the Heimlich maneuver for choking victims by the Plant Protection staff. An excellent program!

Other training in safety procedures included tow-motor and crane operations, hazards recognition, first aid, emergency reaction team operations, etc.

Finally, since this will be my last end-of-the-year report, I would like to add that it has been my privilege to work with a fine Technical Services team for somewhat more than the past ten years.

It has been a truly outstanding R&T support team, made up of highly skilled, dedicated and productive personnel, responsive to Center priorities and programmatic requirements. This recognition indeed prevails throughout the agency!



*Dieselec aircraft engine with exhaust gas dilution tunnel.*

# *In memory*

Lawrence P. Ludwig, who was chief of the Mechanical Components Branch, passed away September 11 after an extended illness. He was 58.

Mr. Ludwig's research on seals over a period of two decades led to advancements in seal technology and resulted in his receiving one of NASA's highest awards—the Exceptional Scientific Achievement Medal.

He is survived by his widow Rahela, daughters Mrs. Theresa Vito and Laurine Ludwig, M.D., son Lawrence Nicholas, a brother and four sisters.

Thomas A. White, who helped build the cyclotron now being used to treat cancer patients at Lewis and who later was the only Lewis employee to be treated under the program, passed away August 27 at the Cleveland Clinic. He was 61.

Mr. white is survived by his widow, Mary; children Margaret, Thomas, Jr., James, Mary Jane and Gretchen; three sisters and a brother. The family lives in Berea.

# Cleveland Clinic, Lewis extend cancer program

Dr. William S. Kiser, Chairman of the Board of Governors of the Cleveland Clinic Foundation (CCF), and Dr. John F. McCarthy, Jr., Director of the Lewis Center, have announced the signing of a milestone agreement between the two organizations.

The agreement provides that CCF will for the next five years operate the Lewis cyclotron in a controlled clinical trial program to determine the effectiveness of neutron radiation cancer therapy. Previously Lewis had operated the facility for the Clinic under an earlier phase of the program for three years.

The new program is supported by a more than $2.5-million five-year grant to CCF from the National Cancer Institute of the National Institutes of Health.

Neutron radiation is not a cure for cancer, only an experimental form of treatment, according to Dr. Antonio R. Antunez, head of the CCF Department of Radiation Therapy and principal investigator in the neutron radiation program.

"Neutron radiation is not the magic bullet to cure cancer," Dr. Antunez says. "I will only say that based on laboratory experiments, neutron radiation may have some advantages. The trials conducted at Lewis are designed to investigate at the clinical level whether this advantage really exists. At the present time, we do not know if this type of radiation is superior."

Dr. McCarthy said Lewis is delighted to be able to make the cyclotron fully available for CCF on this long term basis for clinical investigations. "We are constantly and actively in search of ways in which Lewis can productively interface important community needs," he said. Under the new agreement, the Lewis employees responsible for operation of the cyclotron have left government service and joined the CCF staff.

The CCF/NASA Lewis program draws patients from throughout this region through the Great Lakes Area Neutron Therapy Association. Patients are entered in the trial by their own physicians through GLANTA and in coordination with the CCF Department of Radiation Therapy. GLANTA serves Ohio, Indiana, Kentucky, Michigan, Pennsyvania and West Virginia. Most patients presently in this program are from Northern Ohio, reflecting the relative newness of the GLANTA organization.

Neutron therapy trials are being conducted for tumors of the brain, head and neck, lung, pancreas, cervix, bladder and prostate. The patient's tumor must be localized to the site of origin to make the patient eligible for the program.

Dr. Antunez encourages radiotherapists in the GLANTA area to refer patients to the program. He emphasizes that referring physicians will remain in close contact with their patients.

Lewis used the cyclotron since 1956 for studies in nuclear rocket propulsion and spacecraft nuclear power systems.

### Suggestions sought

*The Awareness Committee has announced that employees suggestions will be invited on the nature and make-up of the Center director's annual message. A questionnaire will be sent out late in October.*

### Advance notice

*The Awareness Xchange program on "Planning to Improve Our Center," held last Tuesday, will be reported in full in the Nov. 6 issue of the Lewis News.*

# Cyclotron's fast neutrons fight cancer

*By Del Zatroch & Dr. James Blue*

*This year is the 10th Anniversary of the joint NASA/Cleveland Clinic Foundation (CCF) decision to use fast neutrons produced by the Lewis Cyclotron to treat cancerous tumors. In this article, we'll review the history of the work and summarize the trial results, which have been reported to the medical oncology community—* **Dr. James W. Blue,** *former Lewis employee and now CCF director of the Cyclotron.*

The original cyclotron, installed in 1955 by General Electric, was limited to accelerating only two kinds of particles. To better match the space radiation environment, the cyclotron was modified to accelerate protons—a particle of the newly-discovered Van Allen radiation belts. This project required a large in-house effort which utilized the skills of many people at the Center.

In 1973 the Center's cyclotron became fully operational as a modern, variable energy, multiparticle cyclotron capable of accelerating protons and other light nuclei.

In 1975 Dr. A.R. Antunez, then chairman of the Department of Radiation Therapy at CCF, decided to propose to use the Lewis cyclotron to treat cancer patients with fast neutrons.

At that time, the National Cancer Institute (NCI) was funding Fast Neutron Therapy (FNT) at three cyclotrons: University of Washington, Naval Research Laboratory and Texas A&M University. These cyclotrons had been built for physics research and therefore their use for FNT was on a shared basis.

With need for the cyclotron in Lewis research having diminished to almost zero, then Lewis Director Bruce T. Lundin agreed to make the cyclotron fully available to the Cleveland Clinic Foundation. Both institutions provided resources for the development of two FNT beams, one vertical and one horizontal; the Lewis participation being carried out under the technology utilization program for technology transfer.

To provide these fast neutron beams, cyclotron modifications and some new construction were required. A structure was built to house a special beam-bending magnet needed to provide vertical beam treatment. A patient treatment control room was also part of the construction where Clinic personnel would be protected from radiation and yet be close to and able to observe the patient during treatment.

The vertical beam, not available at other treatment Centers at that time, permitted the treatment of reclining patients. This was a welcome new feature to Fast Neutron Therapy. In the upright (sitting or standing) patient, displacement of the organs can lead to inaccuracies in targeting some tumors.

Late in 1977, the vertical and horizontal beams were ready for patient treatment.

A small group of patients volunteered to be treated in the CFC/NASA neutron beams and thereby demonstrated to the NCI the treatment capabilities of the remodeled facility.

Subsequently, the NCI gave a grant to CCF to operate the facility and to reimburse NASA for the use of the equipment.

Regional hospitals were invited to join in the program and they formed an organization referred to as the Great Lakes Area Neutron Treatment Association (GLANTA).

## Coming of Age

Neutron therapy was first applied experimentally in the late 1930s by Ernest Lawrence, the Nobel Prize winner and inventor of the cyclotron, working with his physician-brother John. Their basis for using neutrons to treat cancer was the fact that neutrons were known to kill cells and were more penetrating than the conventional photon radiation of that era.
X-rays.

Dr. R. S. Stone of the University of California conducted the first clinical trial with neutrons. This study was interrupted by World War II when cyclotrons were commandeered for defense-related work. Stone's pre-war results showed significant damage to normal tissue as well as tumors, so there was not much enthusiasm to resume neutron therapy in the post-war era.

In addition, there were breakthroughs in conventional photon therapy. The radioisotope Cobalt-60 could be produced by nuclear reactors and in most cases was superior to radium as a source of radiation. Also, developments in radar made it possible to use the new high-powered microwave devices, klystroms, in electron accelerators called linear accelerators, to produce highly effective penetrating X-rays.

Radiobiology became a full-fledged science in the period after World War II. As a consequence, there was a much better understanding of the amount of radiation (dose) required to produce cell damage or cell death and, therefore, better control of the damage to normal tissue.

This work led the English to investigations using a cyclotron at Hammersmith Hospital (London) for neutron therapy. Dr. Mary Catterall, who headed the program, treated head and neck tumors and reported that 76 percent (53 out of 70) of the patients had disappearance of the primary tumor. The comparison group, who were treated with photons (X-rays) only, showed local control in 19 percent (12 of 63) of the cases.

These results spawned studies in the United States, Europe and Japan.

## Emerging Picture

The NCI/CCF program chose a treatment scheme that mixed neutrons with conventional radiation in a 40/60 ratio. This treatment regimen was also used at M.D. Anderson Hospital in Houston, Texas, and at the University of Washington. A 100-percent neutron treatment was used at the Naval Research Lab, Washington, D.C., and at Fermi Laboratory located outside of Chicago.

By combining the patient results of all these centers, a clear picture has emerged:

- Advanced squamous cell tumors of the head and neck do not show any better response to mixed-beam than they do to conventional photon therapy. The all-neutron treatment, however, does appear to be three times more likely to give a complete response than photon therapy.

- Bladder cancer patients treated with mixed-beam showed a significantly better two-year survival than patients treated with photon therapy.

- Brain tumors are most difficult to treat; however, there is some increase in longevity for mixed-beam over photon therapy when the radiation is combined with chemotherapy.

*Patient assumes simulated treatment position as radiation therapy technologist Faith Hasegawa of the Cyclotron staff adjusts tungsten block to shape the neutron field.*

Today, you can be treated with fast neutrons in Cleveland and in Seattle, Washington; Houston, Texas; Chicago, Illinois and Philadelphia, Pennsylvania. Fast neutron therapy has generated worldwide interest and it is now possible to be treated in England, Japan, France and Sweden.

The current National Cancer Institute grant to CCF to use the Lewis cyclotron will end this year, but the Cleveland Clinic has responded to a Request for Proposal (RFP) from the NCI which, if accepted, will provide for treatment of 150 patients per year for the additional years.

The new treatment protocols call for all neutron treatment of the tumors, based on the general feeling that the mixed-beam approach has diluted the advantages that neutrons have to offer.

The advantages that Neutron Therapy is expected to demonstrate over Photon Therapy are threefold:

1. Reduced protection of hypoxic tumor cells;
2. Reduced sensitivity to the cell cycle;
3. Greater killing (rather than just damaging) for the types of tumor cells which exhibit exceptional ability to repair radiation damage.

"It is expected that the new study will show neutrons to be clinically better than conventional radiation for certain tumors," says Dr. Blue. "The goal of the CCF effort is to determine these instances and to define the optimal treatment."

The program has received the backing of former Lewis directors. "And now Center Director Andy Stofan has decided to make the Cyclotron available to the Cleveland Clinic for a new three-year period starting next year," Dr. Blue concluded. □

**MICROGRAVITY WORKSHOP**—*A one-day, interactive workshop considering the effects of gravity in polymer materials science was held last month. The workshop was coordinated by the Center's Materials Division and the Space Experiments Office. Workshop participants included representatives from academia, industry and government.* **James Sutter** *(right) of the Materials Division, a coordinator of the workshop, introduces* **Dr. Mike Runge** *of the 3M Corporation who presented a talk on the "Growth of Crystals in Microgravity."*

**TEACHERS WORKSHOP**—*Teachers from Cleveland's East Tech-South Cluster public elementary schools participated in a recent workshop sponsored by the Center's Office of Equal Opportunity and Educational Services Office. In addition to providing career guidance counseling through science and math demonstration lessons, the workshop discussed career interviewing techniques. Giving a workshop presentation is* **Lynn Bondurant, Jr.** *(standing), chief, Educational Services Office.*

# Lewis' Cancer Treating Cyclotron Shuts Down

January 1991 marked the end of an era at Lewis. In December 1990, the Cleveland Clinic Foundation (CCF) closed down the operation of the Lewis cyclotron, an accelerator which used fast neutrons to treat cancer patients. The cancer treatment program began at Lewis in 1975 as a joint agreement between NASA and CCF.

The cyclotron was built by General Electric in 1955, placed in Building 49, and originally used at Lewis for research related to space nuclear propulsion systems, including radiation damage studies. In 1970 the machine was shut down to update its capabilities. The new cyclotron became operational only a few months before a 1972 decision to terminate nuclear research and applications.

In 1975 Dr. A.R. Antunez, then head of radiation therapy at CCF, agreed to use the cyclotron for a new radiation therapy treatment for cancer patients. The equipment was modified to direct a steam of neutrons, either vertically or horizontally, at a cancerous tumor. The cyclotron generates high speed protons which break down atoms of beryllium to produce neutrons which are aimed at the tumor.

***Participants in the program can take satisfaction in the fact that many people are alive today as a result of the treatment received here at Lewis.***

In the beginning, the program was founded by NASA and CCF. After treatment of patients with both horizontal and vertical neutron beams became routine, the direct NASA support was replaced by funding from the National Cancer Institute (NCI). Four NASA employees, Dr. James Blue, Donald Evancic, Francis Kebberly, and William Roberts, involved with the program, retired from NASA and joined the CCF. The fifth NASA employee, Dr. Regis Leonard, opted to stay with NASA and now heads the Solid State Technology Branch.

In this manner, the Lewis cyclotron joined a national program which included accelerators at Fermi Laboratory, Naval Research Lab, Texas A&M and the University of Washington. The Lewis facility was the first with both vertical and horizontal neutron beams. This dual beam capacity resulted in better treatment plans; this means less radiation to normal tissues surrounding the tumor.

When the NCI decided to terminate nationwide the program in 1988 in order to increase funding in nonradiation cancer therapy research, the Cleveland operation had treated about 1,200 of the more than 4,000 fast neutron patients in the national program.

The question most commonly asked related to the benefit of the program: were fast neutrons better than conventional X-rays? According to Dr. James Blue, cyclotron treatment proved more effective than conventional X-rays

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