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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546
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FOR RELEASE: SUNDAY
Oct. 4, 1964

PROJECT: BEACON EXPLORER-B
(BE-B)

DATE: NO EARLIER THAN Oct. 8 , 1964

CONTENTS

NEWS NASA

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WASHINGTON, D.C. 20546

TELS. WO 2-4155
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FOR RELEASE: SUNDAY
Oct. 4, 1964

RELEASE NO: 64-237

NASA TO LAUNCH
BEACON EXPLORER;
WILL TEST LASER

The National Aeronautics and Space Administration will launch no earlier than Oct. 8 a windmill-shaped satellite designed to make a comprehensive survey of the Earth's ionosphere and to evaluate laser techniques for deriving orbital and geodetic information.

The Beacon Explorer-B (BE-B), formerly designated S-66, will be launched by a four-stage Scout from Vandenberg AFB, Calif., into a near-circular, high-inclination (80-degree) orbit about 575 miles above Earth. The orbital period will be about 103 minutes.

The Beacon Explorer-A satellite (then designated S-66) was launched from Cape Kennedy, Fla., March 19, 1964. However, during burn of the Delta rocket's third stage a malfunction of undetermined origin occurred and the spacecraft failed to achieve orbit. It re-entered the Earth's atmosphere over the South Atlantic Ocean and was destroyed.

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It is the ionosphere, a region of electrically-charged gases, beginning about 35 miles above the Earth, which makes possible long-range radio communications. The ionosphere changes as rapidly as does the Earth's weather. A global survey of this enormous electrified mirror will be as important to predicting communications frequency variations and blackouts as the TIROS weather satellite pictures of global cloud cover have been in predicting the weather.

The 116-pound satellite will transmit a continuous series of radio signals to a network of more than 80 ground stations operated by some 50 scientific groups in 32 countries. This international scientific effort is the most extensive yet in a U.S. space project.

The Beacon Explorer radio signals are transmitted at wavelengths that cause changes in the characteristics of the signals as they pass through the ionosphere. Scientists can get information on the ionosphere by studying the nature of the satellite's radio signals as they are received on the ground.

Scientists around the world have accepted invitations to participate in the program. The Beacon Explorer's signals can be received by simple do-it-yourself ground stations costing less than $5,000 and consisting of an antenna, two radio receivers, a timing device and a recorder.

The ionosphere information obtained by the stations will be exchanged through a Scientific Data Center operated by the Goddard Space Flight Center, Greenbelt, Md.

The satellite also will carry an electrostatic probe experiment to measure electron densities and temperatures in its immediate vicinity. Information from this experiment will be sent by coded telemetry to ground stations of the NASA STADAN network.

In addition to the ionosphere studies, the Beacon Explorer will serve as a test bed for optical and radio tracking experiments related to geodesy--the study of the size and shape of the Earth.

In one experiment, laser (light-beam) devices near NASA's Wallops Station, Va., and near the Goddard Center, will direct beams of light toward fused silica reflectors on the satellite as it passes within range of the station. If the beam strikes the reflectors, part of it will be returned to a receiver near its source. This will enable precise measurements to be made of the satellite's position in space.

Secondly, the Beacon Explorer will transmit on two frequencies which will permit precision tracking by ground stations. This tracking system, similar to that used on U.S. Navy satellites, will continue studies of the Doppler method of satellite tracking and of the influence of the ionosphere on such tracking.

If these experiments are successful, a back-up Beacon Explorer is being considered for more extensive experiments in geodesy -- involving both the laser and Doppler method of satellite tracking.

The Beacon Explorer B has a double role. It is the last of five satellites in the first phase of the NASA ionosphere exploration program and the first of five in a geodetic satellite program announced on Sept. 22, 1964 (NASA Release 64-236).

The Beacon Explorer is part of the scientific space exploration program of NASA's Office of Space Science & Applications. Project management of the satellite is assigned to the NASA Goddard Space Flight Center.

In addition to Goddard, the major participants in the project are the University of Illinois, Pennsylvania State University, Stanford University and the Central Radio Propagation Laboratory of the National Bureau of Standards, an agency of the U.S. Department of Commerce.

The satellite was designed and built by Johns Hopkins University's Applied Physics Laboratory, Silver Spring, Md., under direction of Goddard. The electron density experiment was contributed by Goddard.

The laser experiment is in the program of NASA's Office of Advanced Research and Technology, with project direction assigned to Goddard. The word laser is an acronym for "light amplification by stimulated emission of radiation."

The laser device for use in the tracking experiment was built by Goddard. The satellite-borne reflectors were produced by the Boxton-Beel Co., Brooklyn, N.Y., from fused silica obtained from the Corning Glass Works, Corning, N.Y., and assembled into an array by General Electric's Space Technology Center, Valley Forge, Pa.

(BACKGROUND INFORMATION FOLLOWS)

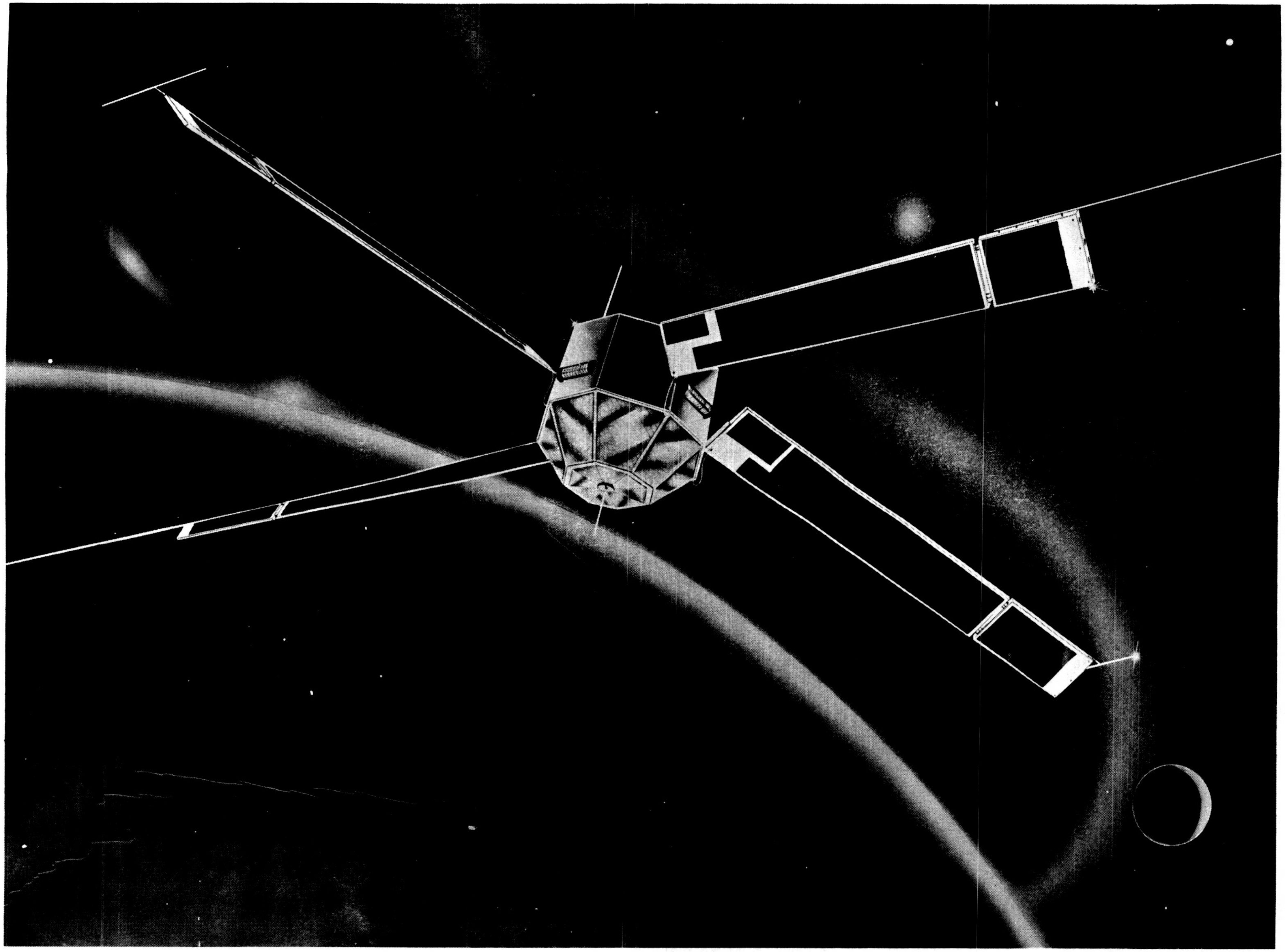
BACKGROUND INFORMATION

The ionosphere satellites fall into three general types depending upon their assigned tasks.

The first type, called direct-measurement Explorers, were designed to measure in detail the characteristics of both positively-charged particles (ions) and negatively-charged particles (electrons) which form the ionosphere. Measurements were made only in the immediate vicinity of the satellite. Two such satellites were launched successfully by NASA: The U.S. Explorer VIII, Nov. 3, 1960, and the U.S.-United Kingdom Airel I, April 26, 1962.

The second type, called topside sounders, transmits radio signals of varying wavelengths which are reflected from the topside of the ionosphere with the echo being received back at the satellite. Topside sounder satellites, by such radar-like technique, permit the study of electron structure as a function of altitude but only on the topside of the ionosphere.

NASA has two topside sounder satellites: the Canadian-built Alouette, launched Sept. 29, 1962, and the Ionosphere Explorer -- Explorer XX -- which was successfully launched Aug. 25, 1964.



NASA

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The Beacon Explorer represents the third type of ionosphere satellite. Its radio transmissions are made at wavelengths which penetrate through the ionosphere to the ground. Thus, it will transmit "raw" cross-section data on the structure of both the top and bottomside (without altitude discrimination) of the ionosphere directly to ground stations. This worldwide network of stations forms a nucleus for the data collection that will make possible a long-sought global survey of the ionosphere.

Expected operating lifetime of the satellite is about two years.

The Beacon Explorer Satellite

The 116-pound Beacon Explorer is an octagonal-shaped satellite with four solar panels extending from its sides like the blades of a windmill.

The shell, 18 inches in diameter and 12 inches high, is made of honeycomb nylon and Fiberglas. Protruding from its top and bottom are the short antenna-like poles used for the electron probe experiment.

The solar panels are covered with cells which convert energy from the Sun into electricity to recharge the nickel-cadmium batteries that provide the power to operate the satellite. The panels are 10 inches wide and five and one-half feet long.

Twice as many solar cells as are needed for initial power have been fixed to the satellite blades. As the cells deteriorate because of radiation effects, reserve banks of solar cells will be commanded into operation.

Extending from the ends of opposite solar panels are two five-foot whip antennas and two dipole antennas for the beacon transmitter.

Four signals will be transmitted at power levels over 100 mw (milliwatts) to ensure good signal-to-noise ratios for ionospheric experiments. Three lower frequency signals -- at 20,40 and 41 megacycles (mc) -- will be transmitted from the two dipole antennas mounted on opposing solar blades. The fourth ionospheric signal -- at 360 megacycles -- will be transmitted from a dipole antenna mounted on the fourth solar blade.

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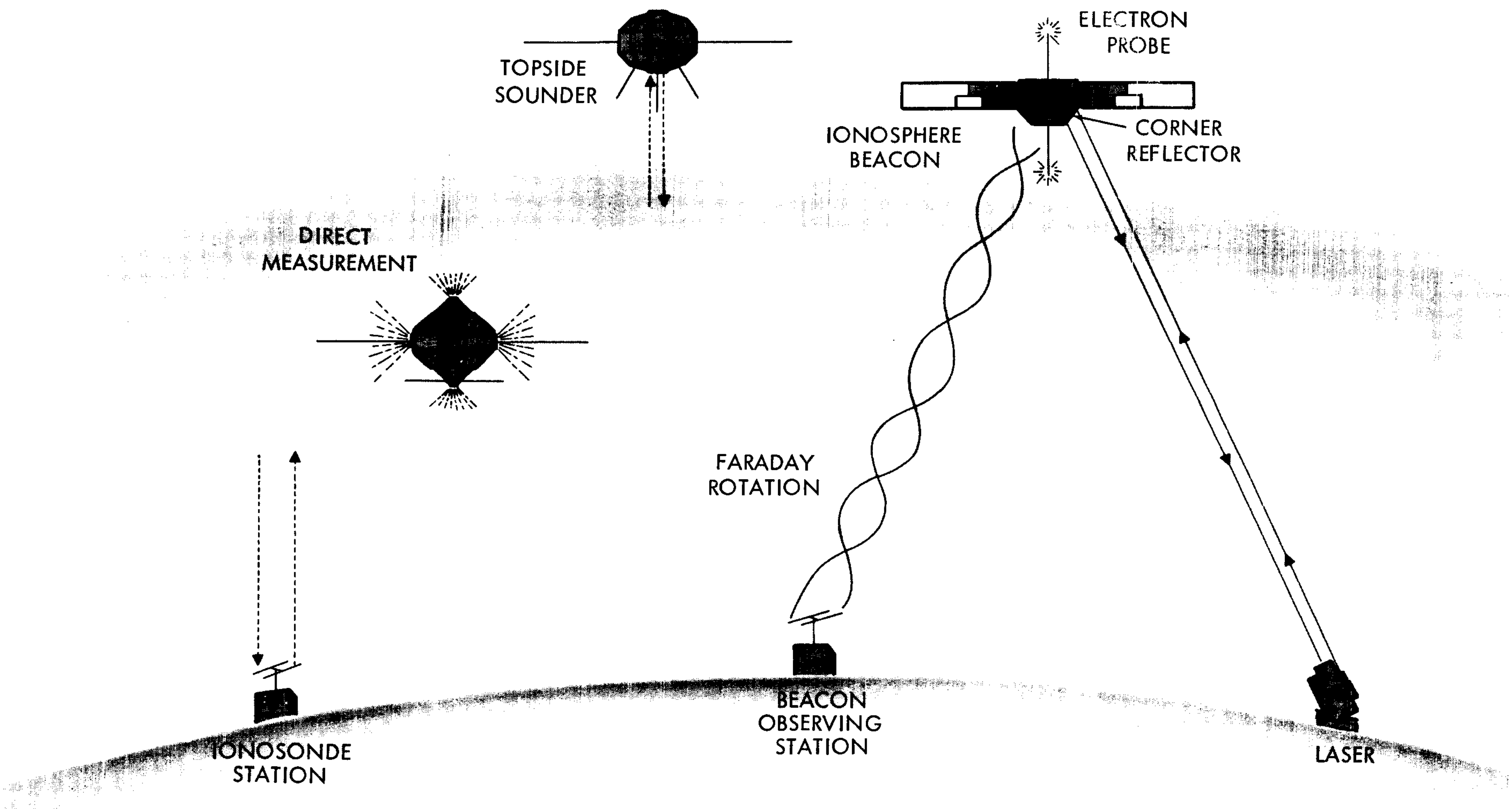

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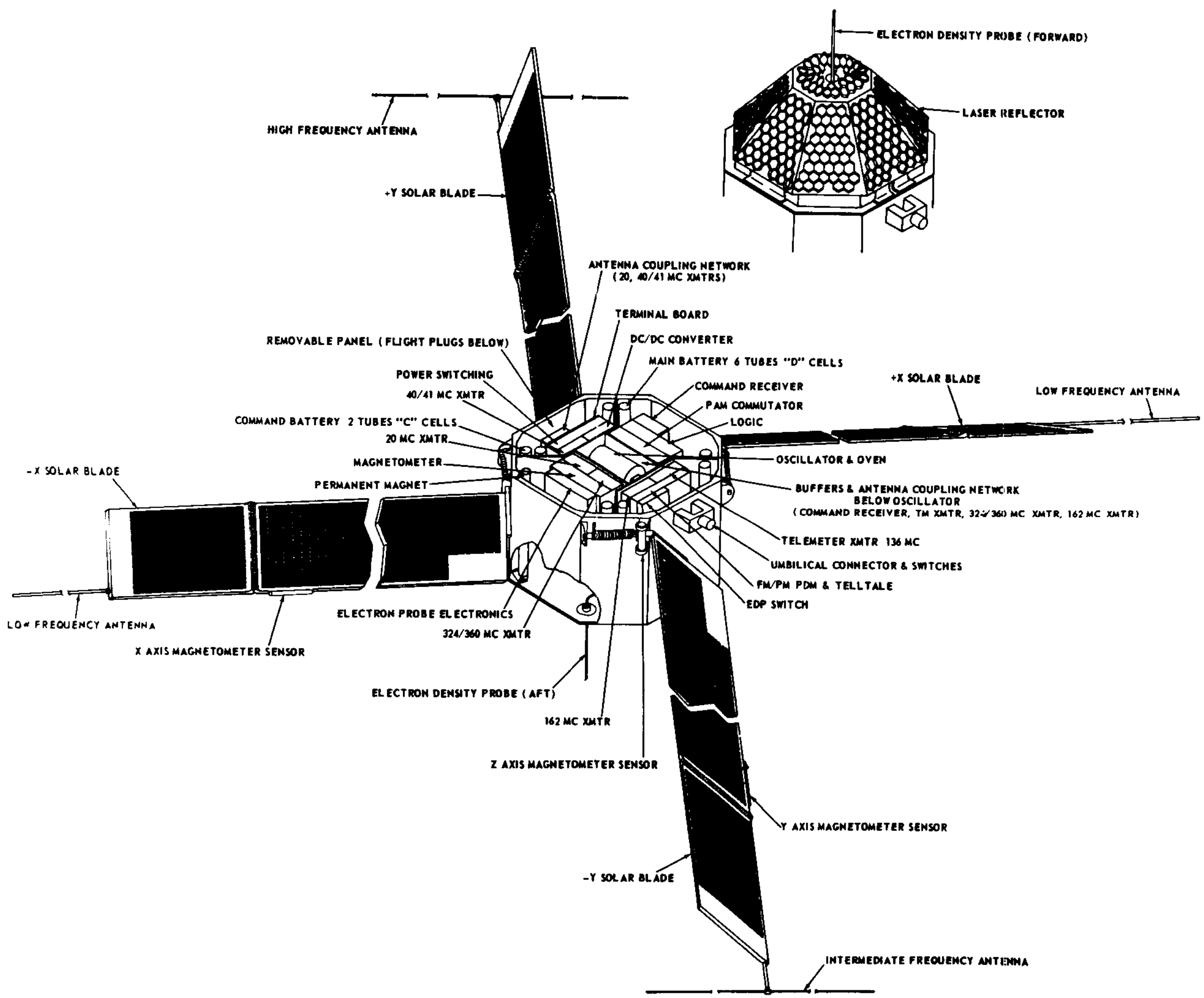
CUTAWAY VIEW



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Greenbelt, Md.

Two signals will be transmitted for the Doppler tracking experiment. One -- at 324 mc -- will be transmitted with the 360 mc signal from the dipole antenna mounted on the satellite body. The second 162 mc signal will be transmitted from a dipole antenna mounted on two solar blades along with a 136 mc signal which will provide information on satellite temperatures, voltages, current and attitude to the NASA Satellite Tracking and Data Acquisition Network (STADAN).

The 360 laser reflectors are one-inch prisms mounted on an eight-sided flat-top pyramid on the satellite. These reflectors -- shaped in such a manner that they will reflect the light beams from almost any angle -- are cube-corners of fused silica, an extremely pure type of glass.

Two bar magnets, 5 3/4 inches long and 7/8ths of an inch in diameter mounted inside the spacecraft shell will passively orient the Beacon Explorer along the Earth's magnetic field. This will point the laser reflectors toward Earth during passages over the northern latitudes and, in addition, will provide more stable radio signals for the ionospheric experiments.

An unusual automatic temperature control system has been built into the satellite. Vacuum insulation between instruments and the shell of the satellite shields the interior from the great variations of temperature on the outside.

When the internal temperature of the spacecraft drops below the desired 70 degrees Fahrenheit, any one of eight thermostats located throughout the satellite will trigger an adjacent heater.

This heating system is fed by a special bank of solar cells which supply the power necessary to maintain the desired internal temperature. Such uniform internal temperature is expected to improve reliability and increase the operating lifetime of the satellite components.

In the launch configuration, the four solar panels, are folded down over the fourth stage of the Scout and held in place by cables of the despin mechanism. The weighted cables are wrapped around the panels. Switches are timed to free the despin cables about seven minutes after the fourth stage burnout, or about 19 minutes after lift-off.

Centrifugal force causes the weighted despin cables to deploy and allows the four solar panels to erect themselves. The first of these two actions causes the spin rate to be reduced from 160 rpm to about 40 rpm. Solar panel deployment lowers the rate to around three rpm. The rate will then be reduced to zero gradually by magnetic despin rods in the solar panels. The total despin process may take from two to four days.

THE IONOSPHERE EXPERIMENTS

The overall scientific objectives of the Beacon Explorer can be summarized briefly as follows:

1. Study the behavior and electron population of the ionosphere as it varies in time and space on a worldwide scale.

2. Relate ionospheric behavior to the solar radiation which produces ionization. This objective is important because it is solar activity that exerts the major influence on the ionosphere and consequently on long-range communications.

3. Determine the geometry and distribution of irregularities in the ionosphere.

Most of the satellite's investigations will be concerned with a search for variations in the structure of the ionosphere. It will do this by measuring the total number of electrons between itself and the ground.

Measurements of electron distribution along the line of sight between the satellite and a ground station will be made in two ways. These are the Doppler Shift and Faraday Rotation methods. Both depend upon the influences that the ionosphere exerts upon the signal sent out by the satellite's radio beacons.

The Doppler Shift Method. One of the characteristics of a signal received from a satellite moving in orbit is that its radio signals are subject to a phenomenon called the Doppler shift. When the satellite moves toward the receiving station, the frequency of the received signal is slightly higher than that sent by the satellite. When the satellite is moving away from the station, the received frequency becomes slightly lower than the transmitted one. This shift of requency is called a Doppler shift, and varies with both the satellite velocity and electron density. By comparing the Doppler shifts at several frequencies, the electron content between the observer and the satellite can be obtained.

The Faraday Rotation Method. This is a rotation of the plane of polarization of the radio waves that is produced by the waves passing through the ionosphere. However, if waves are sent through a layer of charged particles, such as the ionosphere, then the plane of polarization is gradually twisted along a helical path. It is like taking a long, slender curtain and twisting it into a corkscrew shape. This twisting is called the Faraday rotation, and is the result of interactions between the radio waves and the geomagnetic field surrounding electrons in the ionosphere. If the number of times the plane of polarization has been rotated between satellite and Earth can be determined, the electron content can be calculated. This is most easily accomplished by measuring the rotation at several frequencies.

By using a straight dipole antenna on the ground, a maximum strength signal will be received when the polarization of the incoming radio wave is parallel to it, and a minimum signal will be received when it is perpendicular to the antenna.

Variations in the received signal strength also may reveal a patchiness in the ionosphere. The study of such variations should reveal new information on the sources of these localized variations of electron density.

Thus, with simple radio receivers and antennas, a great deal of data can be acquired.

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The extent to which variations in the electron content of the ionosphere can be measured then is limited only by the number and locations of ground stations. And, each station will be able to make a real time measurement each time the satellite passes within radio range.

THE LASER EXPERIMENT

The Beacon Explorer will carry a 10-pound array of fused silica glass reflectors designed to return back to Earth light signals aimed at it from a laser transmitter.

Mounted on the satellite's body are 360 one-inch glass prisms called "cube-corner" reflectors. These are constructed in such a way that light striking them from almost any angle will be returned to its source. They are arranged in the form of an eight-sided truncated pyramid, designed and built by General Electric Space Technology Center.

In one of the experiments, a laser unit mounted on an 18-inch diameter optical telescope housed in a 60-foot high tower located 20 miles south of NASA's Wallops Station, Va., will direct a pulsing beam of red light toward the satellite.

Goddard experimenters plan to attempt the first illumination of the satellite reflectors during the early nighttime passes over Wallops Island.

The planned orbital altitude of about 575 miles will place the Beacon Explorer at a typical slant range of approximately 1,000 miles when it appears, by reflected sunlight, as a star of about the ninth magnitude--20 times fainter than a star which can be seen by the naked eye.

The laser system is mounted on an IGOR (Intercept Ground Optical Recorder) telescope normally used by Wallops to track sounding rockets. Operators will aim the telescope along the predicted path of the Beacon Explorer and when they locate it, they will "flash" the laser light at a rate of one flash per second.

If all goes according to plan, the reflector array will be illuminated and will return a small portion of the light energy to the telescope. The reflected signal will be automatically amplified by a photomultiplier tube (a device that converts optical impulses to electrical signals). A digital counter will record how long it took for the light signal to go and come back.

In the event of overcast or inclement weather, illumination attempts will be delayed until optical sightings are possible.

The measurements of time between initiation of the light signal and reception at the photomultiplier will give the precise distance of the satellite for each second of time. These values will be recorded at the telescope site and later sent to Goddard where they will be compared with distances calculated from other tracking instruments, such as NASA's Space Tracking and Data Acquisition Network (STADAN).

These optical distance measurements are expected to be more precise than those obtained through other tracking procedures and may be used to define the Beacon Explorer satellite orbit more accurately. Other laser tracking experiments will be performed on telescopes near Goddard, over a period of several months after launch.

Results of the experiments may lead to a more definite determination of the Earth's shape and development of improved systems for future optical tracking and communications.

The laser system employs a six-inch synthetic ruby rod which becomes highly energized as it gathers light energy from a xenon gas-filled flash-lamp mounted closely paralled to it in a barrel-like metal and glass housing. The rod is designed so that both ends are polished to act like mirrors. The white light from the flash-lamp excites chromium atoms within the ruby rod which then re-emit light of a uniform color.

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As this red light is reflected back and forth inside the rod, the bouncing rays hit other excited chromium atoms and "stimulate" them to give off more red rays. It is from this stimulated emission that the laser (light amplification through the stimulated emission of radiation) gets its name. These rays are in phase with each other and are parallel to each other as they bounce back and forth between the reflecting rod ends. Scientists term this "coherent" light, in contrast with random sources having diffuse characteristics such as the Sun, electrical and neon gas lamps.

Within a fraction of a millionth of a second this chain reaction builds to a powerful beam that "bursts" out one end of the rod which has been made more transparent than the other. The laser light can be directed into a narrow pencil beam which does not lose its effective strength before reaching the target.

THE ELECTROSTATIC PROBE EXPERIMENT

The electrostatic probe experiment provides a way to measure directly the electron density and temperature in the spacecraft's immediate vicinity. This will assist Beacon Explorer experimenters in interpreting their electron content measurements by providing them with these quantities at the starting point of the radio beacon signals.

Two sensors, one at the top of the spacecraft and the other at the bottom, will extend 10 inches into the plasma surrounding the satellite. Each sensor consists of a cylindrical electrode. These are insulated from each other and from the spacecraft.

A voltage is applied alternately to each sensor and the resulting currents are detected and converted to telemetry signals. The data are recorded at a ground station, processed and interpreted in terms of density and temperature.

SCOUT LAUNCH VEHICLE

Scout is a multi-stage launch vehicle using four solid propellant rocket motors capable of carrying payloads of varying sizes on orbital, space probe or reentry missions. Scout is 72 feet long and weighs 20 tons at lift-off.

Scout was developed by NASA's Langley Research Center, Hampton, Va. It is manufactured by Ling-Temco-Vought, Inc., Dallas.

The four motors are interlocked with transition sections which contain guidance, control, ignition, instrumentation systems, separation mechanisms, and the spin motors required to stabilize the fourth stage. Guidance is provided by a strapped-down gyro system and control is achieved by a combina tion of aerodynamic surfaces, jet vanes, and hydrogen peroxide jets.

Scout is capable of placing approximately a 240-pound payload into a 300-mile orbit or of carrying a 100-pound scientific package some 7,000 miles away from Earth.

Scout stages include the following motors:

First stage:	Algol IIA (Aerojet Jupiter Senior) - 105,000 pounds thrust burning 68 seconds.
Second stage:	Castor (Thiokol Improved Sergeant) - 62,000 pounds thrust burning 40 seconds.
Third stage:	Antares (ABL S-259) - 22,000 pounds thrust burning 36 seconds.
Fourth stage:	Altair II (ABL X-258) - 5,800 pounds thrust burning 24 seconds.

THE BEACON EXPLORER TEAM

The following key officials are responsible for the Beacon Explorer satellite program:

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Roland H. Chase, Laser Project Scientist, OART

Goddard Space Flight Center

Dr. Harry J. Goett, Director

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Joseph B. Schwartz, Associate Manager, Goddard Launch Operations (PMR)

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Milton Green, Program Manager

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Applied Physics Laboratory, Johns Hopkins University

Donald R. Bianco, Project Engineer

Participating Agencies

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Pennsylvania State University

Stanford University

Central Radio Propagation Laboratory, U.S. Bureau of Standards

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	New Delhi	Dr. Y. V. Somayajulu Radio Propagation Unit National Physical Laboratory Hillside Road, New Delhi-12 India
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	Palo Alto, Calif.	Dr. O. K. Garriott
	Point Buchon, Calif.	L. R. Hughes
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	Univ. of Illinois	Professor G. W. Swenson, Jr.

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	Williamsburg Va.	Dr. James D. Lawrence, Jr. College of William and Mary Williamsburg Va.

Tracking, commanding and recording telemetered data will be performed by the Space Tracking and Data Acquisition Network (STADAN) operated by the Goddard Space Flight Center.

The following stations of STADAN will track and perform the necessary command functions to assure proper satellite operation for the experimenters during the expected satellite lifetime of three years:

Blossom Point, Md.
College, Alaska
East Grand Forks, Minn.
Fort Myers, Fla.
Goldstone, Calif.
Johannesburg, S. Africa
Lima, Peru
Quito, Ecuador
Santiago, Chile
St. Johns, Newfoundland
Winkfield, England
Woomera, Australia

In addition, the Smithsonian Astrophysical Observatory (SAO) optical tracking stations, which are operated for NASA, will track the satellite during the launch and early orbits to provide additional tracking coverage for orbit definition.

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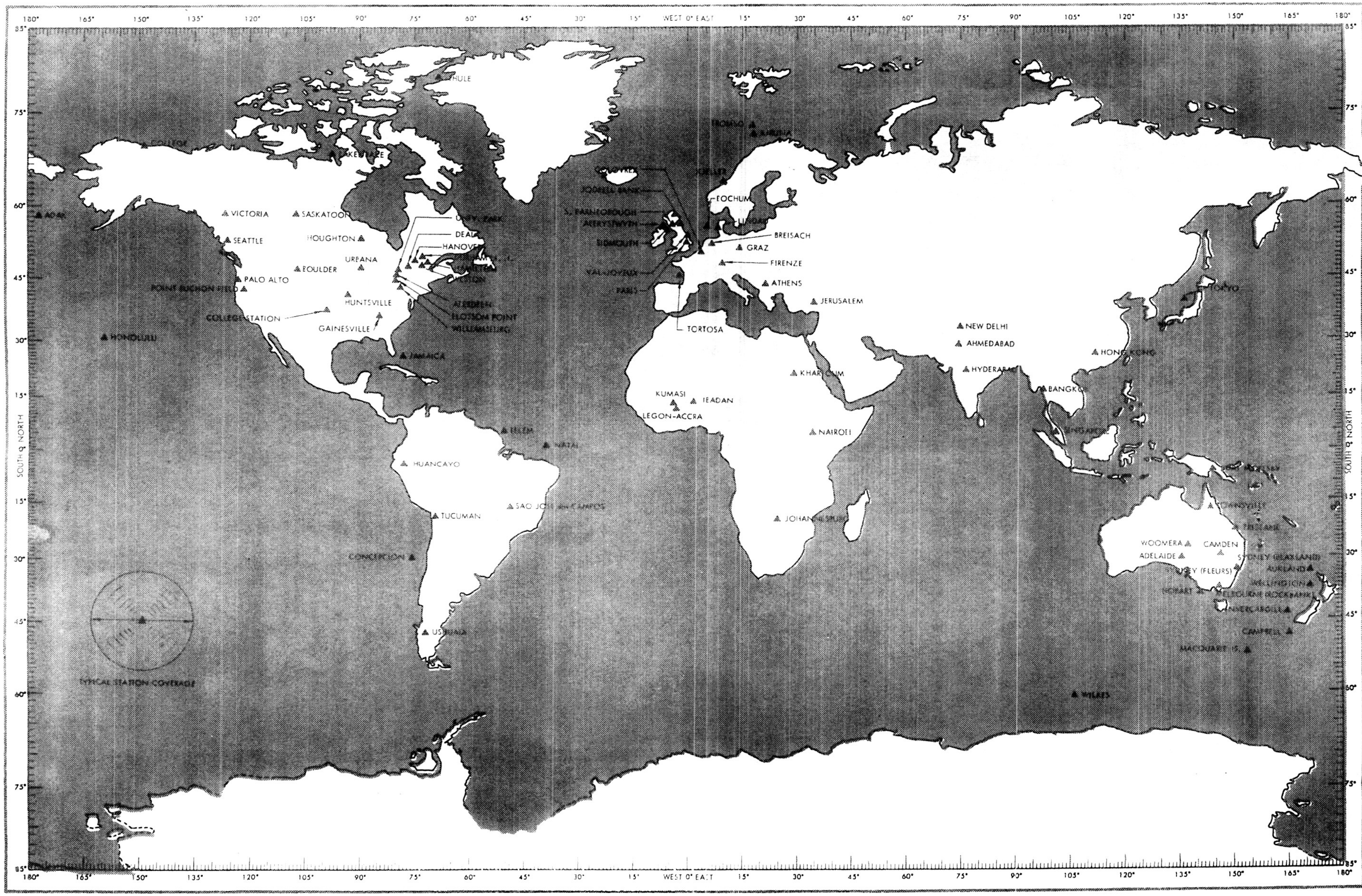

GODDARD SCIENTIFIC DATA CENTER