NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

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FOR RELEASE: MONDAY P.M.
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PROJECT: OGO-F

(To be launched no earlier than June 5, 1969)

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NEWS

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FINAL OGO READIED FOR LAUNCH

The last observatory of the Orbiting Geophysical Observatory (OGO) Program, OGO-F, is scheduled for launch into a low altitude, nearly polar orbit from the Western Test Range, Lompoc, Calif., no earlier than June 5, 1969.

The launch of OGO-F marks the final phase of an era of large automated satellite studies of the nature and variability of the Earth's near space environment under the influence of the Sun.

Planned for the period of maximum sunspot activity, the OGO-F mission will investigate the Earth's upper atmosphere and ionosphere, the auroral regions surrounding the poles, and the edges of the regions of trapped radiation.

Particular emphasis will be placed on the interrelationships between particle activity, aurora and airglow, the geomagnetic field, the neutral and ionized composition, wave propagation and noise, and the input solar energy contributing to ionization and heating.

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The 25 experiments packed in the 1,393-pound observatory--the heaviest of the OGO series--will obtain global data over a complete range of latitudes extending from the Equator to the vicinity of the poles. The experiments were contributed by 10 domestic universities, one foreign university, four government related centers and five private companies.

If successfully orbited by a THORAD-Agena D launch rocket, OGO-F will be designated OGO-6.

The OGO program was initiated in 1960 to undertake the diversified correlative measurements required to understand better Earth-Sun relationships and the near-Earth environment. The large, standardized three-axis stabilized observatory conceived at that time has, with minor modifications, accommodated the 130 experiments assigned to the six OGO missions.

The OGO stabilization system features an active three-axis, five-degrees-of-freedom system which points the bottom portion of the main body always toward the Earth, the solar panels automatically toward the Sun, and rotating experiment packages in the direction of motion.

Booms mounted on the main body, which give OGOs their insect-like appearance, carry experiment packages which are sensitive to spacecraft distrubances, or which require particular viewing directions.

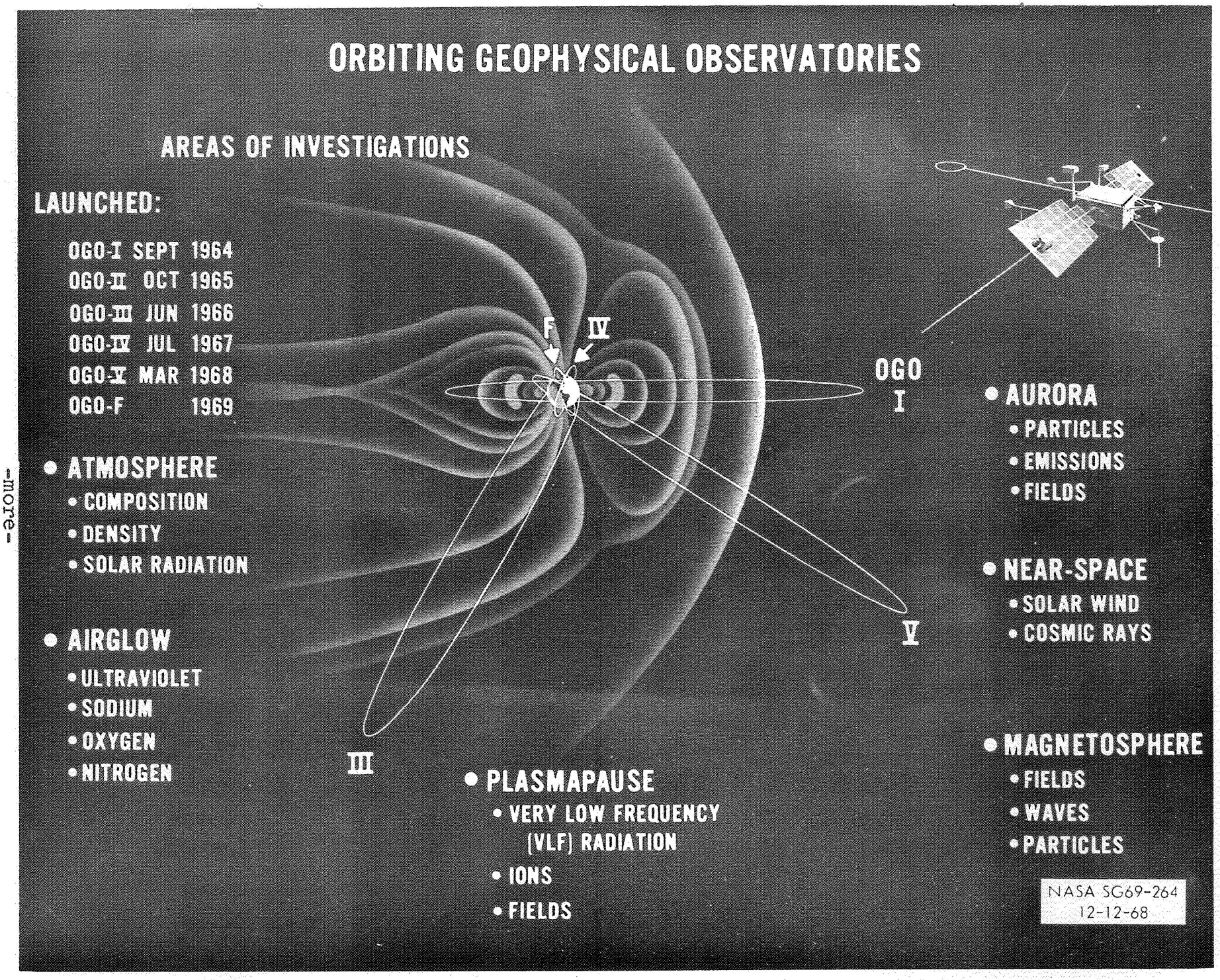
The OGO Communications and Data Handling System designed in the early 1960's was at that time the most advanced incorporated into a satellite, in terms of data rate flexibility and commandable control.

The first OGO, launched in September 1964, near the period of minimum solar activity carried 20 experiments into a highly elliptical orbit for studies of the Earth's magnetosphere. As a consequence of a failure to lock on Earth, OGO-1 entered a spin-stabilized mode. Four and one-half years later, long beyond the expected life of its sytems, the OGO-1 mission is still providing useful data from about half of its experiments.

Two other missions, OGO-3 in June 1966 and OGO-5 in March 1968 were launched into an orbit similar to the OGO-1 orbit. Both observatories are transmitting; OGO-3 is spin stabilized and OGO-5 has performed well in the three-axis stabilized mode for over a year.

OGO-2, launched in October 1965, was the first OGO placed in a low altitude, nearly polar orbit. The mission encountered problems with Earth horizon sensing early in its life but continued to provide data for two years. OGO-4 launched in August 1967, during the period of increasing solar activity performed well for eighteen months. In January 1969, OGO-4 was placed in a holding mode. After the OGO-F launch, the OGO-4 mission will be re-stabilized for correlative inter-satellite studies.

ORBITING GEOPHYSICAL OBSERVATORIES



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The development of a large complex, bus-type, laboratory system like OGO for space research, and the proven long life of these systems under strenuous conditions, is a major technical and engineering achievement. Experience with the OGO program has benefited other space programs and has provided a technology base for the development of advanced space laboratory concepts.

The scientific accomplishments of the OGO program have had a significant impact on the understanding of Earth's space environment. The high data rate of these observatories and the large complement of instruments making simultaneous measurements have made possible high resolution correlative studies which reveal the dynamic nature of this environment.

Analysis of more than 1,200,000 million hours of experiment operations acquired by the first five OGO missions is continuing. Initial findings have been disseminated in over 300 papers and published reports, including 32 papers delivered at the April 1969 meeting of the American Geophysical Union in Washington, D.C.

The OGO results include:

* The first observation of protons responsible for a ring of current surrounding the Earth at a distance of several Earth radii during magnetic storms.

* The first satellite global survey of the Earth's magnetic field, resulting in a proposed new magnetic field model for the International Geomagnetic Reference Field.

* Clear identification of the controlling influence of the Earth's magnetic field on ion population.

* Verification of the existence of an inward boundary, the plasmapause, surrounding the region of stable trapped radiation.

* First evidence that a region of low energy electrons completely envelops the trapped radiation regions.

* First observation of daylight aurorae.

* First worldwide map of airglow distribution.

* New knowledge concerning the Earth's bow shock including the first electric field measurements in the bow shock.

* Evidence of magnetospheric boundary instabilities which could explain how solar particles get into the magnetosphere.

* First detection of non-ducted propagation of very low frequency waves.

* First observation of enhancement of man-made whistler mode waves by magnetospheric focusing.

The OGO results are pointing the way to the resoultion of important questions in energetic particle and wave propagation physics, ionicplasma physics and photochemistry. Data on the ionosphere and propagation mechanisms are expected to lead to improvements in long-range communications. Studies of large scale plasma physics phenomena may help to accelerate laboratory efforts directed towards confinement of hot plasmas.

Understanding of the chemistry of the Earth's atmosphere provides a basis for understanding the environment of other planetary atmospheres and will be an important feature in the foumulation of theoretical models explaining the formation and evolution of planetary environments.

In orbit, OGO resembles a giant, surrealistic insect because of the many arm and leg-like booms, antennas, and wing-like solar panels which jut from its rectangular, box-shaped main body. With its booms and solar panels fully deployed after injection into orbit, OGO is about 49 feet long and 20.5 feet wide. With fully deployed experiment antennas at each end of the solar paddles, the width is approximately 60 feet. Each OGO has more than 100,000 separate parts. During launch, the OGO appendages are folded against the main body.

The Orbiting Geophysical Observatory program is part of the NASA's scientific space exploration study conducted by the Office of Space Science and Applications, Washington, D.C. OGO project management is the responsibility of Goddard Space Flight Center, Greenbelt, Md.

NASA's Lewis Research Center, Cleveland, is responsible for the THORAD/Agena launch rocket. Launch operations are performed by the Air Force's 6595th Aerospace Test Wing under the technical direction of NASA's Kennedy Space Center Unmanned Launch Operations.

OGO prime contractor is TRW Systems, Redondo Beach, Calif. The McDonnell Douglas Astronautics Co., Santa Monica, Calif. developed the THORAD and Lockheed Missiles and Space Corp., Sunnyvale, Calif. produced the Agena stage. More than 100,000 subcontractors and vendors throughout the nation have provided various subsystems and electronics for the satellite.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS)

OGO-F FACT SHEET

SPACECRAFT:

Shape	Main body is rectangular shape, six feet long, three feet wide, three feet high; with appendages deployed, spacecraft looks like giant insect, is 49 feet long and 20.5 feet wide.
Overall Weight	1,393 pounds
Experiment Weight	371 pounds
Appendages	Two 20-foot booms; four four-foot booms; two solar panels, six feet wide by eight and one-half feet long with approximately 80 square feet covered with 33,000 N/P cells; two orbital plane experiment packages nominally 18 by 9 by 10 inches and 15 by 9 by 13 inches.
Power Supply	Solar supply to two 28-volt nickel cadmium batteries using unregulated direct current with maximum capability of about 560 watts.

LAUNCH INFORMATION:

Vehicle	THORAD/Agena D
Launch Site	Western Test Range, Lompoc, Calif.
Launch Azimuth	187 degrees
Date	No earlier than June 5, 1969
Injection	20.9 degrees N. latitude 119.4 degrees W. longitude

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NOMINAL ORBITAL ELEMENTS:

Apogee.....About 680 statute miles

Perigee.....About 245 statute miles

Inclination.....82 degrees prograde

Period.....About 100 minutes.

TRACKING AND DATA ACQUISITION STATIONS

NASA's Space Tracking and Data Acquisition Network (STADAN) will perform tracking, telemetry and data acquisition functions for OGO-F. STADAN stations are located at College, Alaska; Fort Myers, Fla.; Newfoundland; Rosman, N.C.; Winkfield, England; Quito, Ecuador; Lima, Peru; Santiago, Chile; Johannesburg, South Africa, and Carnarvon and Orroral Valley, Australia.

The network is operated by the Goddary Space Flight Center, Greenbelt, Md. Facilities are operated for NASA in Australia by the Australian Department of Supply and in the Republic of South Africa by the South African Council for Scientific and Industrial Research.

OBSERVATORY MANAGEMENT:.....Office of Space Science and Applications, NASA Headquarters, and NASA's Goddard Space Flight Center.

LAUNCH VEHICLE MANAGEMENT:.....NASA/Lewis Research Center

LAUNCH OPERATIONS:.....U. S. Air Force 6595th Aerospace Test Wing under the technical supervision of the NASA Kennedy Space Center Unmanned Launch Operations

PRIME CONTRACTORS:

OFO-F Spacecraft.....TRW Systems, Redondo Beach, Calif.

THORAD Booster.....McDonnell Douglas Astronautics Co., Santa Monica, Calif.

Agena Stage.....Lockheed Missile and Space Corp., Sunnyvale, Calif.

OGO-F SPACECRAFT

OFO-F consists of a main body about six feet long, three feet deep and three feet wide. Attached to this section are 12 appendages.

Two 22-foot-long booms, longest on the satellite, carry experiment instrumentation which must be mounted away from the main body to avoid magnetic and other disturbing effects.

Four four-foot-long booms carry somewhat less sensitive experiments. OGO antennas are mounted away from the main body to take advantage of improved antenna patterns made possible by this technique.

Other external characteristics of the satellite include two box-like packages which carry experiments and can be rotated so that the experiment packages can be aligned in the plane of the orbit.

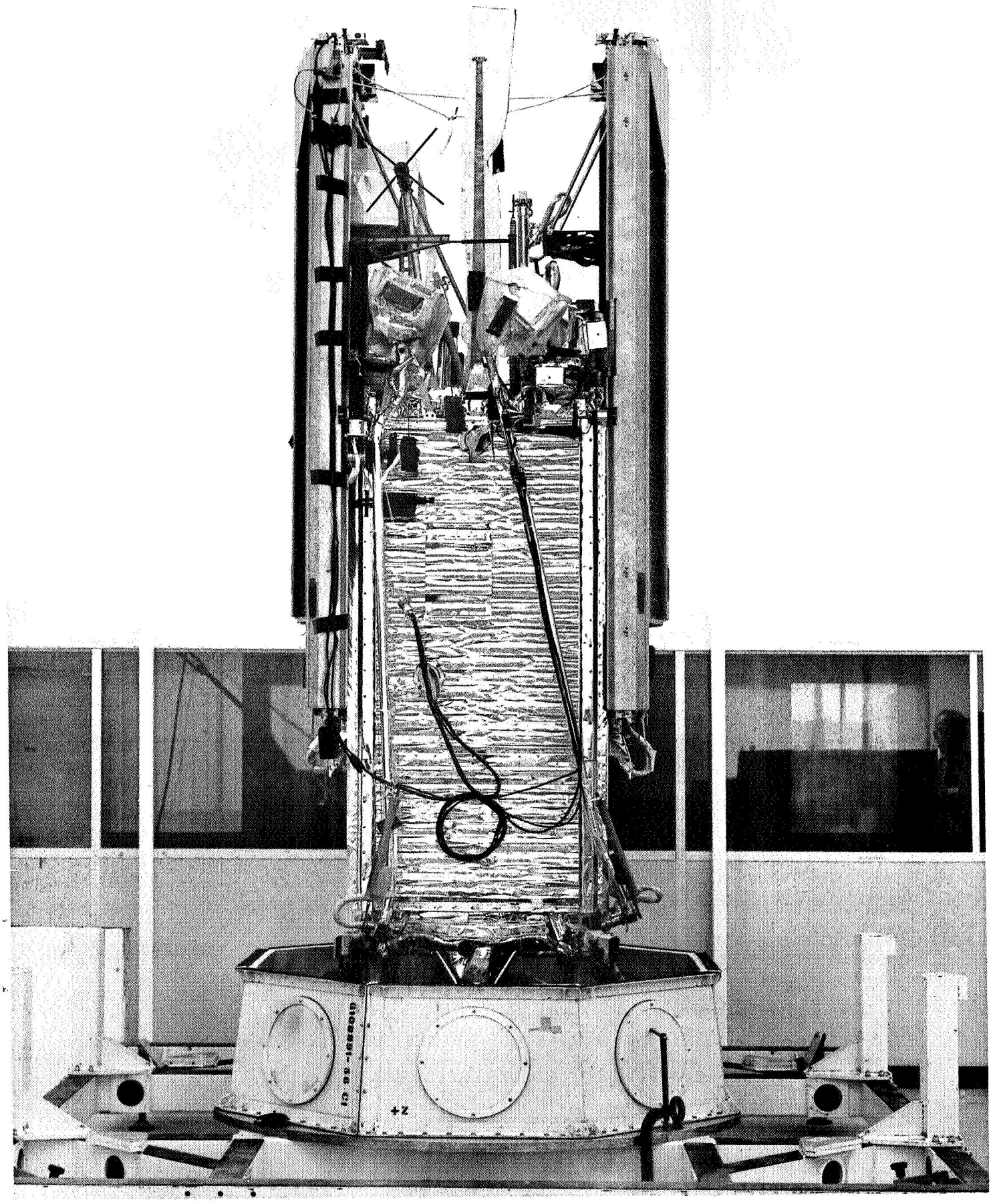
These packages, called the OPEPs (Orbital Plane Experiment Packages) are of different sizes. The largest is approximately 18 inches long, 10 inches high and 9 inches deep. They carry experiments which will take readings in the orbital plane of the satellite.

Also mounted externally are attitude control jet nozzles which are placed on booms at one end of OGO. This placement increases the lever arm action and helps stabilize the satellite and reduce gas system weight.

Two larger solar-cell panels convert solar energy into electrical power for satellite operation. The panels are mounted on a shaft running through the main body. They rotate automatically, as orientation of the observatory changes, to permit them to face the Sun continously.

Two solar oriented experiment packages (SOEPs) are mounted on the solar panels. These packages contain experiments designed to look toward the Sun.

Experiments not sensitive to the satellite's local environment are mounted on the inside of two large hinged doors. The doors can be opened for access to equipment or experiments.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Power Subsystem

The 33,000 solar cells mounted on the two solar arrays provide about 560 watts of electric power.

This is stored in two 12 ampere-hour nickel-cadmium batteries.

An average of 100 watts and a peak of 140 watts of power are reserved for experiments.

Attitude Control System

The OGO-F attitude control system is designed to keep the satellite stabilized in all three axes (pitch, yaw and roll), within two degrees of local vertical, with five degrees of the Sun, and one side oriented toward Earth. The OPEPs are then oriented within five degrees of the orbital plane. This stabilization provides a platform for accurate directional measurements.

Basically, the control system consists of horizon scanners, Sun sensors, servos, gas jets, electrically-driven flywheels and associated electronics.

Horizon scanners sense the infrared edge of the Earth and provide error signals to the inertial flywheels and gas jets which force the satellite to turn about in the roll and pitch axes insuring that the bottom of the main body always points towards Earth.

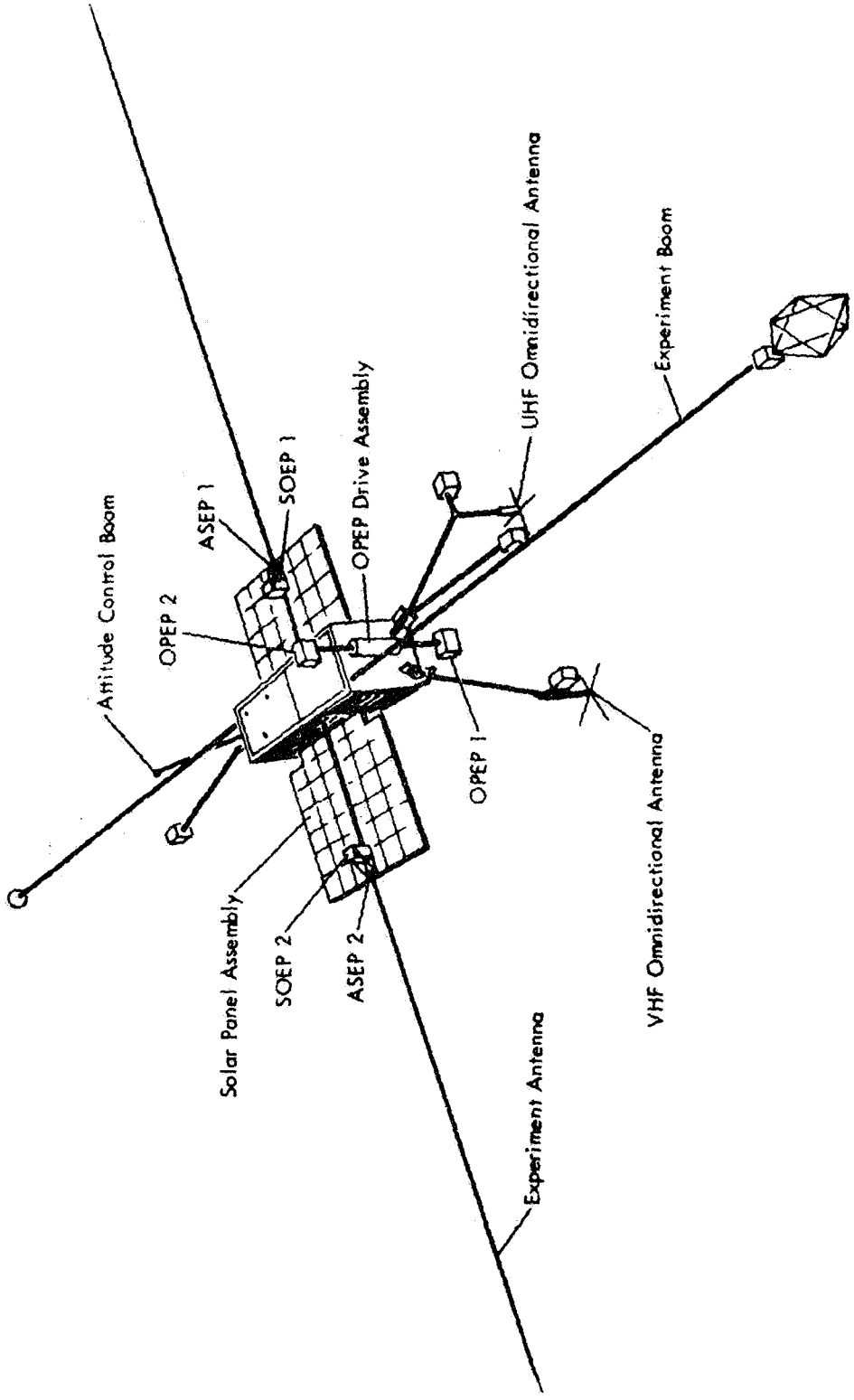
Error signals for controlling yaw motion, and rotation of the power-producing solar panels, are controlled by Sun sensors situated on the ends of the panels.

The body yaw torque, produced by another inertia wheel and a set of gas jets, keeps the axis of the solar panels normal and the plane of the main body thermal radiation louvers parallel to the Sun line.

A third portion of the system controls the OPEPs to permit some of the experiments to look along the path of the satellite.

These experiments are directed forward in the plane of the orbit and normal to the observatory-Earth line. OPEPs can also scan across the orbital plane on command.

THE OGO-F OBSERVATORY



The OPEP sensor is a gyroscope operated in a gyrocompass mode. Its error voltage controls a drive which rotates the OPEPs with respect to the body.

Thermal Control System

A combination active and passive thermal control system regulates temperatures in the electronics system compartments of the observatory.

The temperatures of all assemblies within the main body are kept between about 41 to 95 degrees F. by sets of radiating panels and 101 temperature-actuated aluminum louvers located on three sides of the main body.

The temperatures of appendage packages containing experiment instruments are controlled by a similar thermal balance technique, except that louvers are not used. Generally heaters are used to maintain temperature limits when the observatory is in eclipse or when experiments are turned off.

This system is designed to keep the temperatures within the appendage containers within the range of about 32 to 104 degrees F.

Communications and Data Handling

The OGO communications and data handling system is designed to provide for tracking and command functions both for satellite housekeeping and experiment operation and telemetry data for 20 to 30 separate experiments.

The main telemetry is a wide-band PCM (pulse code modulation) system using a nine-bit word and capable of operating at three data rates which are selected by ground command.

The realtime data rate capability of the OGO-F system ranges from 8,000 to 64,000 bits-per-second. Data stored in two tape recorders at 8,000 bits-per-second play back at 128,000 bits-per-second.

The system is composed of two redundant data handling units that operate with outputs transmitted to Earth in realtime or are connected to one of the two tape recorders provided for storing up to three hours or 86,000,000 bits of data. These data are transmitted by four-watt wide-band transmitters at 400 mhz.

A special purpose telemetry system, capable of operating from an experiment whose output is an FM (Frequency Modulated) signal varying from up to five standard subcarrier oscillators.

For back-up, a second mode of the special purpose system includes the transmission of the output of the wide-band telemetry system. The special purpose transmitter is rated at 0.5 watts at 400 mhz.

Data Processing

Data received on magnetic tape by the world-wide network of Tracking and Data Acquisition Stations (STADAN) will be forwarded to the Goddard Space Flight Center.

Tracking data sent to Goddard will be used for computation of an accurate orbit for experimenters' data analysis and for spacecraft operations.

Taped data will be processed by high-speed computers. When the processing is completed, digital computer tapes will be produced for each experimenter.

These tapes will contain data from each individual experiment, necessary timing information, as well as data on spacecraft temperatures, voltages, and orbital data -- the standard housekeeping information.

The production data processing conducted at Goddard will be basically a computer sorting operation, providing experimenters with raw data from their experiments. Following the necessary analysis and evaluation by experimenters, data for the scientific community will be published in scientific journals.

The data will also be submitted to the National Space Science Data Center at Goddard Space Flight Center for the use of other interested scientists.

OGO-F SCIENTIFIC OBJECTIVES AND EXPERIMENTS

The 371 pounds of instrumentation for the 25 experiments of the OGO-F mission cover the broad spectrum of the space science disciplines, and are correlative investigations in solar, aeronomy, energetic particle, auroral and airglow physics.

The information collected by these various experiments should help in understanding better the Earth's environment and the time-dependent relationship that exists in galactic, interplanetary and planetary events, with emphasis on solar-terrestrial interactions.

At the present time in space exploration, scientists know how to make many of the individual measurements of the magnetic field, particle flux, ionization, etc.

The important question facing space scientists concerns the interrelations between these quantities and the establishment of detailed cause-and-effect relationships.

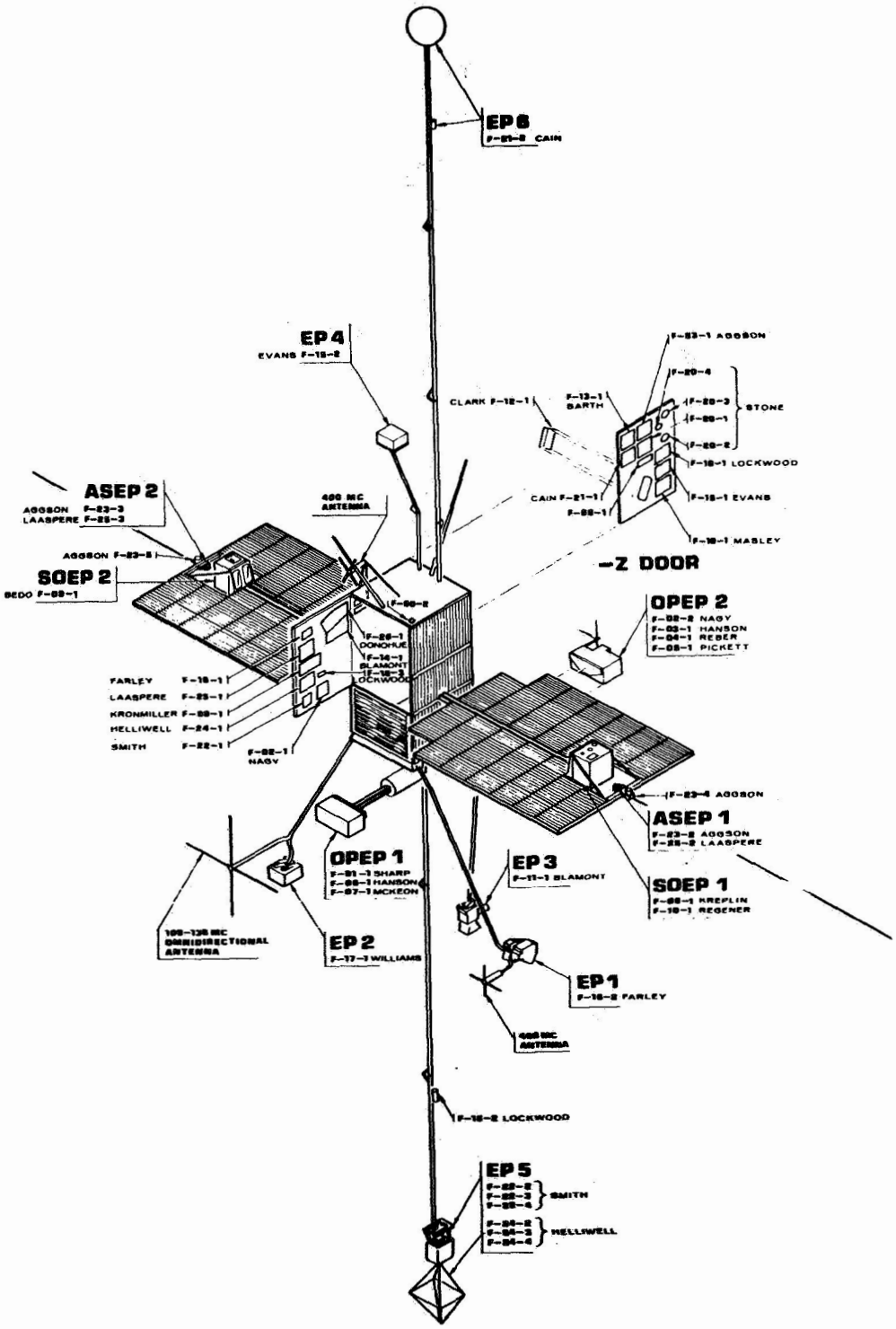
An example is the desire of physicists to study the density and composition of the upper atmosphere, and the way the atmosphere is affected by radiation from the Sun and by energetic particles.

To obtain this type of information requires several coordinated experiments, and large data reduction systems (to turn the data into easy-to-understand language), which leads to the requirement of large scientific spacecraft in the OGO class.

Following are some of the OGO-F near-Earth areas of investigation:

* Atmospheric and ionospheric measurements
* Auroral and airglow studies
* Solar radiation experiments
* Radio emission measurements
* Magnetic field measurements
* Cosmic ray experiments

OGO-F Experiment Locations



These investigations should help achieve some of the following objectives:

* New knowledge on the latitude and time-dependent variations of the pressure, temperature, density and chemistry of the neutral atmosphere surrounding the Earth;

* The relationship between solar X-ray and ultraviolet emissions and their effect on the Earth's ionosphere, atmosphere and airglow;

* Further insight into the precipitation of energetic particles and the influx of solar comsic rays into the auroral and polar regions and the occurence of aurora and polar cap blackout;

* Measurement of solar ultraviolet and X-ray emissions during a period of high activity;

* More information concerning low energy particles trapped in the Earth's magnetic field; the intensity of the magnetic field, and the overall relationship of the phenomena with very low frequency radio noise, ionospheric absorption and solar activity;

* The definition of long-term changes in the geomagnetic field and further refinement of global magnetic field data as part of the United States' contribution to the World Magnetic Survey; and

* A better understanding of interplanetary and galactic space as revealed by cosmic rays reaching the Earth from the Sun and from galactic sources.

A technical description of each of the OGO-F experiments follows in order to help place in context the types of instrumentation used and the specific areas to be studied by each experiment.

Atmospheric and Ionospheric Studies

Atmospheric Density (Lockheed Missile and Space Company, Palo Alto, Calif., - G. W. Sharp)

The primary objective of the experiment is to measure the spatial and temporal variations in the neutral atmospheric density throughout the OGO-F orbit. Of particular interest is latitude variation, day-night variations, and solar activity-correlated variation in the atmospheric density.

A thin metallic ribbon, suspended between the pole pieces of a permanent magnet, is mounted in the OPEP looking along the velocity vector of the spacecraft. The atmospheric gas, having effectively the velocity of the vehicle, exerts a pressure on this ribbon which is proportional to the atmospheric mass density and the square of the velocity of the gas with respect to the ribbon.

Electron Temperature and Density (Univ. of Michigan, Ann Arbor, Mich., - A. F. Nagy, NASA/GSFC - L. H. Brace)

This experiment will contribute to a coordinated study of the aeronomy of the upper atmosphere. It measures the ambient electron temperature and density and it also provides information on the equilibrium potential of the spacecraft.

The operating principle of the instrument is the following: A small cylindrical probe is placed outside the sheath of the spacecraft and the D.C. potential of the probe is varied a few volts with respect to the spacecraft. The resulting collected current versus applied voltage characteristics are then used to derive electron temperature and density and spacecraft potential. The experiment uses two Langmuir probes placed on OPEP-2 at 90 degrees to each other, with one probe looking into the velocity vector. This arrangement is helpful in evaluating experimentally the orientation effects on the volt-ampere characteristics.

Neutral Atmospheric Composition (NASA/GSFC - C. A. Reber; Univ. of Michigan, Ann Arbor, Mich., - G. R. Carignan)

The primary objective of this experiment is to study the behavior of the concentrations of major constituents (N_2, O_2, O, He, and H_2,) of the Earth's neutral atmosphere during varying solar activity and magnetic disturbances, and during diurnal, seasonal, and latitudinal variations. A secondary objective is to obtain accurate measurements of the concentration of trace constituents of the Earth's neutral atmosphere.

A quadrupole mass spectrometer is used to obtain the atmospheric composition data. The spectrometer system consists of a quadrupole analyzer, in which mass separation occurs within a dc and a radio frequency electric field, an enclosed dual filament electron bombardment ion source, an electron multiplier, supporting electronics for operating the analyzer and source, and a break-off device for exposing the evacuated mass spectrometer to the atmosphere once in orbit.

Atmospheric Ion Concentration and Mass (NASA/GSFC - R.A. Pickett)

The objective of this experiment is to study the atmospheric thermal positive ion concentration and mass in the range from 1 to 45 atomic mass units (AMU).

The instrument used is a Bennett rf ion mass spectrometer oriented in the orbit plane and located in OPEP-2. The spectrometer consists of a tube with a series of plane-parallel knitted grids mounted normal to the axis of the tube. A-C and D-C fields accelerate the ions down the length of the tube toward a collector. To reach the collector the ions must pass through a retarding potential. Only those ions satisfying the velocity and phase conditions established by the fields will receive sufficient energy from the fields to pass the retarding potential and impinge on the collector.

Ion Mass Spectrometer (Southwest Center for Advanced Studies, Dallas, Texas, - W. B. Hanson)

The objective of this experiment is to provide measurements of the ambient ion composition along the spacecraft's orbital path for those positively charged ions in the range from 1 to 40 AMU.

The instrument consists of a 90 degree sector magnetic analyzer, an electron multiplier detector and a linear automatic ranging electrometer located in OPEP-1. The system is capable of measuring ion concentrations of the order of 10 ions per cubic centimeter.

Ionosphere Ducting (SWAS - W. B. Hanson)

This experiment measures ion concentrations and temperatures throughout the OGO-F orbit in order to provide an understanding of atmospheric chemistry and heating phenomena in the upper atmosphere. The phenomena of whistler ducting and ducting of the ionosonde pulses from topside sounders along magnetic field lines are believed to be caused by field aligned irregularities in the electron (ion) concentrations. The experiment also provides high resolution measurement of horizontal ion concentration gradients (ducts) with a sensitivity of one part per thousand in ion concentration and 300 meters in spatial resolution.

A planar ion trap is utilized to measure ion temperature, ion concentration and horizontal irregularities in ion concentration. The entire experiment consists of an analyzer and associated electronics enclosed in a single package in OPEP-1.

Energy Transfer Probe (Faraday Laboratories, La Jolla, Calif., - D. McKeown)

The primary objective of this experiment is to determine the energy accommodation and drag coefficients for high and low atomic weight metals. A secondary objective is to determine variations in upper atmosphere density by monitoring variations in the kinetic-energy flux.

The instrument consists of four energy transfer probes located in OPEP-1. A shutter is positioned in front of the probes to chop the upper atmospheric stream. Each probe employs a temperature-sensitive quartz crystal to detect energy transfer. The frequency increase of a probe, during the period when the shutter is open, is proportional to the energy transferred to the crystal sensor. Of the four probes, two are used to measure the accommodation co-efficients of gold and aluminum, one measures the kinetic energy flux of the upper atmospheric stream and one is used as a control.

Solar Radiation Measurements

Solar X-ray Emissions (U. S. Naval Research Laboratory, Washington, D.C., - Mr. R. W. Kreplin)

Measuring the solar X-ray energy input to the Earth and its variations in order to understand the geophysical parameters of the upper atmosphere is the objective of this experiment. Changes in the solar radiation is one of the primary environmental influences affecting the ionosphere. In particular, solar X-ray bursts accompanying flares and active prominences are the direct cause of increased D region ionization, which in turn is responsible for radio fadeout, sudden cosmic noise absorption (SCNA), and other manifestations of the sudden ionospheric disturbance (SID) event. By establishing a set of X-ray indices of solar activity, correlation with other geophysical phenomena can be made. The time variation of X-ray emissions play an important role in the formation and variations in the D and E regions of the ionosphere and appear to constitute the predominent strongly variable component of solar radiation reaching the lower ionosphere.

The instrumentation consists of two detectors, a proportional counter for the 2 to 20 Kev range and a scintillator/photomultiplier for the 20 to 150 Kev range. The detectors are located in SOEP-1.

Solar Ultraviolet Emissions (Air Force Cambridge Research Laboratories, Bedford, Mass., - D. E. Bedo)

The objective of this experiment is to monitor radiation intensities in the extreme ultraviolet (160 angstrom degrees to 1600 angstrom degrees) portion of the solar spectrum. It will provide needed information on intensity levels and the temporal variations of these levels for correlative sutides of UV emissions with ionospheric and atmospheric phenomena.

The instrument consists of 6 collimator-plane grating spectrometers located in SOEP-2 which saan the wavelength range from 160 to 1600A with an effective overall resolving power of 100. The six spectrometers cover independent but overlapping spectral ranges to give redundancy everywhere but at the spectral extremes. The wavelength scan is carried out in 513 steps which covers the entire spectral range. The experiment can also be commanded to any of 15 short scans of 65 steps each. An aspect system associated with the experiment yields a measure of any departure made by the experiment axis from the mean solar vector.

Solar Ultraviolet Survey (Univ. of New Mexico, Albuquerque, N. M., - V. H. Regener)

The objective of this experiment is to provide long term observations of the intensity of solar radiation in the ultraviolet region of the spectrum over the wavelength from 1850 to 3500 angstroms. Solar radiation at these wavelengths is largely responsible for the dissociation of oxygen in the upper atmosphere, for the existence and the vertical distribution of atmospheric ozones, and for the temperature distribution in the upper atmosphere.

The experiment uses a quartz prism spectrograph mounted in SOEP-1 which is programmed to scan the ultraviolet spectrum in eight ranges, most of them approximately 300 angstroms wide. In addition, there are two ranges in the visible spectrum, one affected by ozone absorption in the yellow-orange region, the other in the range from 3500 to 5000 angstroms, where ozone does not absorb. The simultaneous monitoring of the visible radiation is intended mainly as a check on the equipment.

Airglow and Auroral Studies

Airglow and Auroral Emissions (U. of Paris, Paris, France, - J. E. Blamont)

The primary purpose of the experiment is to study the emitting regions at 6300 angstroms (the red line of atomic oxygen) and at 3914 angstroms (0-0 band of the first negative system of nitrogen, N_2+) during airglow and auroral phenomena.

Photometric measurements of the 6300 angstrom airglow altitude distribution will provide information for studies of dissociation of O_2 by solar ultraviolet radiations, dissociative recombination of ions with electroms in the ionosphere and direct excitation of O by thermal electrons. Interferometric measurements in the same band will provide the shape and width of this line for study of temperature distribution. Observations of the 3914 angstrom airglow will provide data on resonance radiation by N_2+ and ionization and excitation of N_2 by solar X-rays.

Observations during aurorae will provide information on excitation mechanisms such as: energetic particle dumping, dissociative recombination with electrons, fast proton collisions, and optical resonances (sunlight Aurora).

The photometer is mounted on a short boom and views toward Earth. The 3914 angstrom region of the spectrum is observed by using a second interference filter which automatically alternates with the 6300 angstrom interference filter in front of the photometer. A stepping mirror provides a 32 degree scan from the observatory horizontal plane.

The Fabry-Perot interferometer is mounted in the spacecraft main body and looks out the spacecraft side panel. A moving plane mirror permits the instrument to scan the desired emission region. With variation in spacecraft altitude the angular position of the mirror is altered through use of signals from the spacecraft horizon sensors.

Ultraviolet Photometer (U. of Colorado, Boulder, Colo. - C. A. Barth; Packard Bell - E. F. Mackey)

The purpose of this experiment is a study of the spatial distribution and temporal variations of the intensity and density of atomic hydrogen (1216 angstroms) and oxygen (1304 angstroms) in airglow, in the outer atmosphere of the Earth; and in proton and electron excited aurora.

The instrumentation consists of a two-channel photometer designed to measure ultraviolet radiation between 1100 and 2500 angstroms. Both channels have lithium fluoride filters with a band pass of 1100 to 2500 angstroms incorporated within the PM tube. One photometer channel is used this way, the other has a calcium fluoride filter placed between the lithium fluoride window and the columnated aperture. The band pass of the latter is 1250 to 2500 angstroms. Thus, the 1100 to 2500 angstrom and 1250 to 2500 angstrom regions are measured simultaneously.

The photometer is mounted on the observatory so that the photomultipliers look along the Earth radius vector in a direction away from the Earth. The PM tubes are protected from extended periods of direct sunlight by a ground controlled door.

Celestial Lyman-Alpha (Aerospace Corp., El Segundo, Calif., - M. A. Clark, CIT, Pasadena, Calif., - G. Munch)

The objective of the experiment is a study of the zenith angle distribution of Lyman-Alpha radiation on a global basis. The primary source of radiation is the Sun, and the distribution occurs by resonant scattering from the neutral hydrogen geocorona. From such measurements, the density variation and extent of the hydrogen atmosphere may be deduced. It may be possible to obtain information regarding the hydrogen temperature and to observe interplanetary neutral hydrogen.

The instrumentation used is a 3 angstrom bandwidth photometer at 1216 angstroms with a five degree field of view. The photometer is mounted externally on the top side of the observatory. A rotating 45 degree mirror makes a circular scan of the sky above the observatory once each orbit. The instrument contains an atomic hydrogen absorption cell for analysis of the radiation distribution very close to resonance. Three different absorption profiles are employed.

Sodium Airglow (Univ. of Pittsburgh, Pittsburgh, Pa., - T. M. Donahue; Univ. of Paris, Paris, France, - J. E. Blamont)

The objective of this experiment is to measure the variation of the absolute brightness of the Sodium D lines (5890 angstroms and 5896 angstroms) and the atomic oxygen green line (5577 angstroms) during the day, twilight and night airglows.

Global measurements of the altitude and the content of the sodium layer should elucidate many problems related to dust influx, sporadic-E, noctilucent clouds, atmospheric circulation, and atmospheric chemistry.

The instrument is a photometer with a scanning mirror (similar to the Airglow and Auroral Emission photometer) and views out the side of the observatory main body.

Low Energy Auroral Particles (NASA/GSFC - D. S. Evans)

The objective of this experiment is to measure with high energy resolution the spectrum of auroral particles over the energy range 0.7 Kev to 20 Kev and to investigate the variations in down flux of these particles.

The experiment uses eight channel electron multiplier particle detectors located on the end of a short boom. One of these provides background measurements while the remaining seven detect low energy charged particles. The experiment is oriented so as to measure particles precipitated at high latitudes. Five of the seven active detectors measure charged particles (either electrons or protons as selected by ground command) in fixed energy bands. The plate voltage on the other two detectors is slowly swept as as to obtain a high resolution scan over the energy spectrum 0.7 Kev to 20 Kev.

To obtain high resolution energy spectra in or near the auroral zone, data acquired by these detectors are stored on an experimenter provided tape recorder. Tape recorder playback is through the Observatory Special Purpose Telemetry System.

Energetic Particle Measurements Trapped and Precipitated Electrons (UCLA, Los Angeles, Calif., - T. A. Farley)

The objectives of this experiment are (1) to discover the mechanism by which electrons are precipitated into the atmosphere at values of two and greater; (2) to understand the relationship between particle precipitation and particle trapping in the outer radiation zone; (3) to relate the phenomenon of particle precipitation to the structure of the magnetosphere, particularily with the neutral point on the day side and the extended tail on the night side; and (4) to correlate particle precipitation with other time-varying phenomena, such as local magnetic and electric field variations, large-scale geomagnetic disturbances, and auroral displays.

The instrumentation consists of six scintillator photomultiplier electron detectors to observe directions and flux intensities in the range 45 to 1200 Kev. Five of the 6 detectors are configured to accept arriving particles in a +4 degree cone; the sixth is an omni-directional detector. The experiment is mounted on the end of a short boom.

Trapped and Precipitated Electrons (NASA/GSFC - D. J. Williams)

The primary objective of this experiment is to study the temporal and spatial behavior of medium to high energy electrons at low altitudes in the outer zone and to correlate this information with similar studies made during solar minimum. The experiment measures the intensities of trapped and precipitated electrons in the energy range 40 Kev to 2 Mev.

Measurements are obtained with seven solid-stage detectors, mounted in a shielding head at the end of a short boom. Four of the seven detectors are used to measure trapped electrons and the remaining three are employed for precipitation and back-scattering measurements.

Neutron Monitor (Univ. of New Hampshire, Durham, N. H., - J. A. Lockwood)

The objective of this experiment is to examine the longitude, latitude and time variation of the neutron albedo flux, and to study relationships with energetic particle trapping. The instrument consists of a neutron detector mounted approximately 15 feet from the observatory on a long boom. The neutron detector monitors the total neutron flux in the energy interval two Mev to 10 Mev and consists of a He^3 proportional counter encased in a scintillator material which is a moderator for fast neutrons. The moderator is surrounded by charged-particle counters to "gate-off" the neutron counter whenever a charged particle enters the moderator. This reduces the effects of total neutron production within the detecting system.

Low Energy Solar Cosmic Rays (McDonnell-Douglas Aeronautics Corp.,- Santa Monica, Calif., - A. J. Masley)

The objective of this experiment is to investigate solar cosmic rays; to relate the results to solar and ionospheric studies, and to calibrate ground-based multifrequency riometer stations.

The detector is designed to measure the flux and energy level of low energy protons (five to 80 Mev) and alpha particles (20 to 150 Mev) over an intensity range from less than galactic background to $3x10^4$ particles/cm^2-sec-ster. The sensor unit to the detector uses two semiconductor particle detectors arranged in the form of a telescope.

Solar and Galactic Cosmic Rays (CIT - E.C. Stone)

This experiment will study the acceleration and injection of high-energy particles by the Sun, and their storage and propagation in interplanetary space; the nature of the small fluxes of solar particles that produce polar cap absorption; and the shapes of the galactic proton, alpha, and electron spectra and their variation under solar modulation.

The experiment uses three charged particle telescopes located in the observatory main body. The first is an energy loss-range telescope consisting of seven solid state detectors, separated by various absorbers, arranged in a single stack and surrounded on the side by a plastic scintillator anti-coincidence counter. This telescope will measure the differential energy spectra of protons (0.4 to 300 Mev), alpha particles (0.4 to 1200 Mev.) and electrons (1 to 1000 Mev).

The second is an energy loss Cerenkov telescope which detects particles arriving within a cone of 35 degrees half-angle with respect to the vertical and analyzes them for energy loss in a solid state detector and velocity in a quartz Cerenkov Radiator. Differential energy spectra of protons (350 to 100 Mev) alpha particles (1400 to 4000 Mev) and for Li, Be, B, C, N, and O particles will be obtained.

The third is an energy loss telescope which detects particles arriving within a cone of 4.5 degrees half-angle with respect to the vertical and also analyzes them for energy loss in a solid state detector. This telescope will provide information on large solar flares (protons: 17 to 100 Mev; Alpha particles: 70 to 1400 Mev).

Magnetic and Electric Fields Studies

Magnetic Field Measurements (NASA/GSFC - J. C. Cain)

The objective of this experiment is the understanding of the physical processes creating and altering the main geomagnetic field and the sources external to the Earth's surface contributing to the ambient field in the F-layer. If possible, gross features of surface magnetic anomalies will be located and mapped for use by geologists. The external sources to be investigated include tidal oscillations of the ionosphere by the gravitational gradients of the Sun and Moon (lunisolar magnetic variations) and diurnal changes on quiet days (Sq). During periods of magnetic disturbance, the effect of trapped plasma and variations in the external pressure on the magnetosphere will be evaluated (Dst/DS). One of the main functions of the analysis will be to separate the magnetic variations seen at the Earth's surface that arise from the ionosphere from those with sources in the trapping and boundary regions.

Other effects such as longitudinal pulsations in field and electrojets (auroral and equatorial) are to be investigated and correlated with other experimental data on the spacecraft.

The detector consists of two Rubidium vapor magnetometers which measure total sclar magnetic field. In addition, the Rubidium Frequency divided by four is transmitted on Special Purpose Telemetry to allow study of smaller amplitude pulsations by special techniques. The twin-cell magnetometers are mounted at the end of a long boom sufficiently far from the main body that the interference is less than 1 gamma. The overall accuracy of the measurement is of this order.

Magnetic Field Fluctuations (NASA/JPL - E. J. Smith; UCLA - R. E. Holzer)

The objective of this experiment is to investigate natural magnetic field variations within the ionosphere and lower magnetosphere in the frequency range of 0.01 to 1 kHz.

Signals originating within or above the ionosphere have been detected at the Earth's surface throughout this frequency range. Several species of micropulsations are known to exist below 1 Hz, and hydromagnetic emissions between one and five Hz have been found to exhibit a complex frequency-time behavior. At higher frequencies and at high latitudes, auroral zone emissions (in bands below 500 Hz and from 500 to 1500 Hz) and extremely low frequency whistlers have been observed.

Consequently, the relation between time-varying magnetic fields, charged particle variations and electromagnetic radiation in, or near, the auroral zone will be of special interest.

The instrumentation consists of a triaxial search coil magnetometer located at the end of a long boom. Each sensor output represents the instantaneous amplitude of the fluctuating component of the ambient magnetic field intensity at frequencies between 0.01 and 1200 hz.

Electric Field Measurements (NASA/GSFC - T. L. Aggson)

This experiment provides one dimensional measurement of ambient electric field intensities and of field gradients in the ionosphere. The electric field intensities which may cause auroral and high geomagnetic latitude electric current will also be measured. Time dependent field intensity changes will be studied which are magnetic field aligned irregularities, plasma waves and/or irregular magnetic fluctuations.

The experiment consists of two 30-foot antennas which act as electric field sensors. The antenna and preamplifiers are mounted at the extremities of the two solar arrays.

VLF Polarization and Wave Normal Direction (Stanford University, Stanford, Calif., - R. A. Helliwell)

The primary objectives of this experiment are the measurement of the polarization, wave-normal direction, and the electric/magnetic (E/M) ratio of signals in the frequency range 30 Hz to 30 kHz.

The secondary objectives include the measurement of antenna impedance and current with and without bias, the measurement of the phase and amplitude of VLF transmitter signals, the measurement of the integrated natural VLF noise, and the measurement of the observed ion-gyrofrequency whistlers. The latter measurements will be compared with the data observed by ion probes and with the magnetometer observations.

The sensors consists of three mutually perpendicular magnetic loop antennas and one electric dipole located at the end of a long boom. Signals from various inputs are preprocessed by phase shifting and adding in different combinations. Various frequency bands with widths of 120 Hz or 2.4 kHz can be selected in the frequency range 30 Hz to 30 kHz.

Whistler and Low Frequency Electric Field Study (Dartmouth College, Hanover, N. H., - T. Laaspere)

The primary scientific objective of the experiment is to study the electric field of waves such as whistlers over an extended range of frequencies (10 Hz to 295 kHz broadband; 200 and 540 kHz narrowband). A secondary objective is to measure the impedance of the experiment's electric dipole antenna at several frequencies (8, 24, 104.5 and 285 kHz). Whistler and emission data will be compared with observations made simultaneously at an existing network of whistler stations, which extend north-south from the Arctic to the Antarctic (approximately along 65 degrees W. geographic longitude).

It is known that emission phenomena such as Chorus and hiss are related to particle fluxes such as those observed under auroral conditions. To increase understanding of these relationships, the measurements of this experiment will be correlated with data obtained simultaneously via other experiments on particle fluxes. Simultaneous data on electron density and positive ion composition will be used for studying lower hybrid resonance phenomena.

This experiment shares the two 30-foot antenna of the Electric Fields Experiment.

LAUNCH VEHICLE

The 1370-pound OGO-F satellite will be launched with a Thorad-Agena into an elliptical orbit with an apogee of 684 statute miles and a perigee of 249 miles. The orbit will be inclined 82 degrees to the Equator and has a period of 99.8 minutes.

The launch vehicle consists of a Thorad first stage and an Agena-D second stage. The Thorad is a long tank version of the Thrust Augmented Thors (TATs) used to launch previous polar Orbiting Geophysical Observatories. The greater burn time made possible by increasing the propellant capacity of the Thor along with increased burning time for the three strap-on solid propellant rocket motors makes it possible to boost about 20 per cent more payload with the Thorad than the original TAT. The Thorad carries approximately 45,000 pounds of RJ-1 fuel and 100,000 pounds of liquid oxygen. The three Thorad strap-on rocket motors provide 52,130 pounds of thrust for 37 seconds.

Only one burn of the Agena's 16,000-pound-thrust engine is necessary to place the OGO spacecraft in the required orbit. For the OGO-F mission, the Agena carries approximately 3,837 pounds of UDMH (Unsymetrical dimethylhydrazine) fuel and 9,660 pounds of IRFNA (Inhibited red fuming nitric acid) oxidizer.

The launch vehicle including the 18.7-foot fiberglass clamshell shroud stands 109.5 feet high.

The launch window for OGO-F is selected to allow the spacecraft to remain in sunlight during its first 48 hours in space. To achieve this objective, liftoff is scheduled for 10:32 a.m. EDT on June 5. The launch window closes at 11:26 a.m. EDT that day.

OGO-F TYPICAL SEQUENCE OF FLIGHT EVENTS

Event	Seconds After Lift-off
Lift-off	0
Start first roll program	2.0
Stop first roll program - start first pitch program	16.0
Solid motor burnout	38.6
Eject solid motors	102
Thorad Main Engine Cutoff	219.9
Thorad Vernier Engine Cutoff	228.9
Thorad-Agena separation	235.4
Transfer WECO steering commands to Agena	235.7
Agena engine ignition	288.1
Shroud separation	296.9
Agena engine cutoff	523.4
OGO-F separation	630.9
Begin Agena Yaw maneuver	633.9
Complete Agena yaw maneuver	663.9

COUNTDOWN MILESTONES FOR THORAD-AGENA-D OGO-F LAUNCH

Event	Minutes
Countdown initiation	T-595
Thorad preparation	T-595
WECO and Thorad telemetry checks	T-575
Destruct Checks	T-525
Solid motor arming	T-450
Gantry removal	T-360
Agena tanking	T-180
Agena pressurization	T-85
Countdown evaluation and start terminal count	T-60

OGO-F THORAD/AGENA FLIGHT SEQUENCE

Launch Azimuth 187.0 degrees

Event	Nominal Time (Sec.)	Altitude Statute Miles	Surface Range from Pad Statute Miles	Inertial Vel/MPH
Solid Motor Burnout	38.6	3.14	.68	1092
Solid Motor Ejection	102	17.1	8.32	1557
MECO	219.9	82.5	117.9	8590
Thorad-Agena Separation	235.4	98.2	149.8	8489
Agena Engine Ignition	288.1	143.4	256.7	8081
Agena Engine Cutoff	523.4	248.0	944.6	17,555
OGO Separation	630.9	248.9	1435.0	17,570

Thorad Phase

After liftoff the Thorad-Agena vehicle rises vertically with its main engine and three strap-on solid motors firing. Starting at approximately 2 seconds after liftoff and continuing until 16 seconds, the vehicle rolls to the desired flight azimuth of 187 degrees. The three solid rocket motors provide thrust for approximately 39 seconds and are ejected at about 102 seconds after liftoff. During the booster rocket flight, a dog leg maneuver is necessary to attain the 82-degree final orbit inclination. This maneuver is executed between 102 and 124 seconds after liftoff.

Main engine cutoff of the Thorad is commanded by the WECO guidance system along with the initiation of the Agena start sequence. A Thorad fuel depletion switch can also command main engine cutoff.

Agena Phase

Separation of the Agena stage is initiated by a command from the WECO ground station, and small retrorockets are fired to retard the flight of the Thorad. About 33 seconds later the Agena and OGO-F spacecraft pitch maneuver is initiated. The pitch maneuver is completed in 13 sec. and the Agena engine is started. During the 237-second Agena burn period, steering correction commands are transmitted from the WECO ground station.

At T plus 297 seconds the nose fairing is jettisoned. And at T plus 523 seconds the Agena main engine is shut down.

OGO Separation

During the approximately 107 seconds between Agena engine cutoff and OGO separation, the vehicle is maintained at an attitude horizontal to the Earth's surface.

Separation occurs at T plus 631 seconds by firing explosive bolts on the spacecraft adapter. Compressed springs then push the OGO spacecraft away from the Agena stage at a rate of about 4.5 feet per second.

A few seconds after separation, the Agena vehicle is yawed 90 degrees to the right so that any residual propellant that might be vented will not contaminate the spacecraft and will tend to increase the separation of the two orbits.

OGO-F EXPERIMENTERS & EXPERIMENTS

Dr. G. W. Sharp Lockheed Missile and Space Co.	Atmospheric Density
Dr. A. F. Nagy University of Michigan	Electron Temperature & Density
Dr. W. B. Hanson Southwest Center for Advanced Studies	Ionospheric Ducting
C. A. Reber Goddard Space Flight Center	Neutral Atmospheric Composition
Dr. R. A. Pickett Goddard Space Flight Center	Atmospheric Ion Concentration and Mass
Dr. W. B. Hanson Southwest Center for Advanced Studies	Ion Mass Spectrometer
Dr. D. McKeown Faraday Laboratories	Energy Transfer Probe
R. W. Kreplin U. S. Naval Research Lab.	Solar X-Ray Emissions
Dr. D. E. Bedo Air Force Cambridge Research Laboratories	Solar UV (160 to 1600Å) Emissions
Prof. V. H. Regener University of New Mexico	Solar UV_o survey (1,850 to 3,500 A)
Prof. J. E. Blamont University of Paris	Airglow and Aurora Emissions
Dr. M. A. Clark Aerospace Corporation	Celestial Lyman-Alpha
Prof. C. A. Barth University of Colorado	UV Photometer
Prof. J. E. Blamont University of Paris	6,300 Å Airglow Emission

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Dr. D. S. Evans Goddard Space Flight Center	Low-Energy Auroral Particles
Prof. T. A. Farley University of California at Los Angeles	Trapped and Precipitated Electrons (45 to 1,200 kev)
Dr. D. J. Williams Goddard Space Flight Center	Trapped and Precipitated Electrons (40 kev to 2 mev)
Prof. J. A. Lockwood University of New Hampshire	Neutron Monitor
Dr. A. J. Masley McDonnell-Douglas Astronautics Co.	Low-Energy Solar Cosmic Rays
Prof. E. C. Stone California Institute of Technology	Solar and Galactic Cosmic Rays
Dr. J. C. Cain Goddard Space Flight Center	Magnetic Field Measurements
Dr. E. J. Smith Jet Propulsion Laboratory	Magnetic Field Fluctuations
Dr. T. L. Aggson Goddard Space Flight Center	Electric Field Measurements
Prof. R. A. Helliwell Stanford University	VLF Polarization and Wave Normal Director
Prof. T. Laaspere Dartmouth College	Whistler and Low Frequency Electric Fields
Prof. T. M. Donahue University of Pittsburgh	Sodium Airglow

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OGO-F PROGRAM TEAM

The following key officials are responsible for the Orbiting Geophysical Observatory satellite program:

NASA Headquarters

Dr. John E. Naugle, Associate Administrator for Space Science and Applications

Jesse Mitchell, Director, Physics and Astronomy Programs

Thomas L. Fischetti, Geophysical Observatories Program Manager

Dr. Robert F. Fellows, OGO-F Program Scientist

William L. Lovejoy, Agena Program Manager

G. M. Truszynski, Associate Administrator for Tracking and Data Acquisition

NASA Goddard Space Flight Center

Dr. John F. Clark, Director

Wilfred E. Scull, OGO Project Manager

Nelson W. Spencer, OGO-F Project Scientist

NASA Lewis Research Center

Seymour C. Himmel, Assistant Director for Launch Vehicles

H. Warren Plohr, Agena Project Manager

Roger S. Palmer, OGO-F Mission Engineer

Prime Contractor

Spacecraft design, development, fabrication and test, TRW Systems, Inc., Redondo Beach, Calif.

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Major Subcontractors

Battery Cells -- Gulton Industries, Inc., Metuchen, N.J.

Gyroscopes -- Minneapolis-Honeywell Corp., Boston, Mass.

Horizon Scanners -- American Standard, Advanced Technology Division, Mountain View, Calif.

Power Converters -- ITT Industrial Products Div., San Fernando, Calif.

Reaction Wheels -- Bendix Eclipse Pioneer Div., Teterboro, N.J.

Solar Cell Modules -- TRW Systems, Inc., Redondo Beach, Calif.

Solar Cells -- Hoffman Electronics Corp., El Monte, Calif.

Static Inverters -- Kinetics Corp., Solana Beach, Calif.

Tape Recorders -- RCA Astro-Electronics Division, Princeton, N. J.

Tape Transporters (in Ground Support Equipment) -- Ampex Corp., Redwood City, Calif.

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