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IMMEDIATE

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NASA TO LAUNCH COOPERATIVE INTERNATIONAL SATELLITE

NASA, in cooperation with The Netherlands Aerospace Agency (NIVR) and the Science and Engineering Research Council of the United Kingdom, plans to launch the international Infrared Astronomical Satellite (IRAS) aboard a Delta launch vehicle from Vandenberg Air Force Base, Calif.

The earliest the launch of the American-Dutch-British satellite will occur is 6:17 p.m. PST, Jan. 25, 1983. The launch window will open for 12 minutes each day. IRAS will be placed in a 900-kilometer (560-mile), circular, near-polar orbit. It will circle the earth every 103 minutes -- 14 orbits per day.

The orbit altitude was chosen to avoid contaminating the instruments by earth's atmosphere at lower altitudes and to minimize false readings from proton strikes in the Van Allen radiation belts at higher altitudes.

January 12, 1983

(NASA-News-Release-83-1) NASA TO LAUNCH COOPERATIVE INTERNATIONAL SATELLITE (National Aeronautics and Space Administration) 35 p CSCL 22B

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The satellite, unhampered by atmospheric obscuration, will perform the first all-sky survey to search for objects that emit infrared radiation. The resulting sensitivity to the observed frequencies may be as much as 1,000 times greater than previous work from the ground, airplanes, balloons or rocket flights.

The mission's primary products will include a catalog of infrared sources and infrared sky maps.

IRAS is 3.6 meters (12 feet) high and 2.16 m (7 ft.) in diameter. It weighs 1,076 kilograms (2,365 pounds) at launch.

The satellite carries a cryogenically cooled, Ritchey-Chretien telescope with a 57-centimeter (22.4-inch) effective aperture. The telescope is expected to fill a significant scientific gap in measurements of the electromagnetic spectrum between the visible region and radio waves.

It is expected to provide data on the energy budget of the universe, and on the birth and death of stars.

Infrared telescopes require a cold environment to detect signals above the thermal noise of the system. Therefore, IRAS carries a cryogenic system containing 475 liters (125 gallons) of liquid helium.

The helium will maintain the infrared detector array in the focal plane at about 2 Kelvin (-455 F) throughout the lifetime of the mission. Mission duration is determined by the time required for the liquid helium to boil off to space.

IRAS will collect about 900 million bits of data a day. Twice each day, during passes over the IRAS tracking station in England, the contents of the satellite's tape recorder will be dumped to the ground at 1 million bits a second. At the same time, the working plan for the next half day will be radioed to the satellite.

A portion of the data from the satellite will be examined immediately by the IRAS ground operations team in England to check on the satellite's condition and improve later observation plans. The full data set will be sent by communications satellite to NASA's Jet Propulsion Laboratory, Pasadena, Calif., for extensive processing. Further modifications to the observation plans may result from examination of the data at JPL. The data will be processed into a set of final products that will include an infrared sky map and a catalog summarizing observations during the mission.

The IRAS satellite consists of the telescope and the spacecraft. The spacecraft supplies necessary support, such as the onboard computer, tape recorder, radio, electric power and pointing control, to the telescope.

Three other experiments, in a single package built in the Netherlands, will be aboard IRAS. They are placed in the focal plane array of the telescope and include a low-resolution spectrometer, a shortwavelength channel detector and a chopped photometric channel detector.

Jet Propulsion Laboratory is the American project manager for NASA's Office of Space Science and Applications. JPL is also responsible for processing data from IRAS, with the Science Data Analysis System. NASA's Ames Research Center, Mountain View, Calif., under JPL direction, managed the development of the telescope.

The Netherlands is responsible for design and manufacture of the spacecraft, the additional experiment package, integration and test of the complete satellite, and satellite launch preparations. The Netherlands Aerospace Agency (NIVR) has managed the task, which was executed by an industrial consortium consisting of Fokker and Hollandse Signaalapparaten, assisted by the National Aerospace Laboratory (NLR). The University of Groningen provided the Dutch Additional Experiment package.

The United Kingdom, with funding through the Science and Engineering Research Council, provides tracking and data acquisition, and preliminary data analysis. The control center and the tracking station are located at Rutherford Appleton Laboratory at Chilton, 32 kilometers (20 miles) south of Oxford, England.

The Delta Project Office at NASA's Goddard Space Flight Center, Greenbelt, Md., provides the Delta launch vehicle, and Kennedy Space Center, Fla., is responsible for the launch at Vandenberg Air Force Base.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

GENERAL DESCRIPTION

The IRAS satellite consists of a spacecraft and the telescope and its detector system. The spacecraft, or bus, supplies electrical power and pointing control, and houses IRAS telemetry and computer electronics.

The IRAS telescope weighs 810 kg (1,785 lb.) and the spacecraft bus weighs 266 kg (585 lb.).

IRAS weighs a total of 1,076 kg (2,372 lb.). Its height is 3.6 m (12 ft.) and width is 2.16 m (7 ft.) with its solar panels folded; 3.24 m (10.6 ft.) when the panels are deployed. Solar panels supply the 250 watts of power required to operate all the satellite's systems.

Nickel-cadmium batteries store energy during launch, sun acquisition, and during solar eclipses (which can occur for a maximum of 16 minutes for each orbit, if the mission were to continue to late November).

The Netherlands was responsible for the design and manufacture of the spacecraft bus, and integration, testing and launch preparations of the satellite under the auspices of the Netherlands Aerospace Agency (NIVR). The spacecraft was built by the Industrial Consortium IRAS (ICIRAS), consisting of Fokker and Hollandse Signaalapparaten, assisted by the National Aerospace Laboratory (NLR).

The United States is responsible for design and manufacture of the telescope, processing of the experimental data to produce the final infrared catalog, and the launch vehicle.

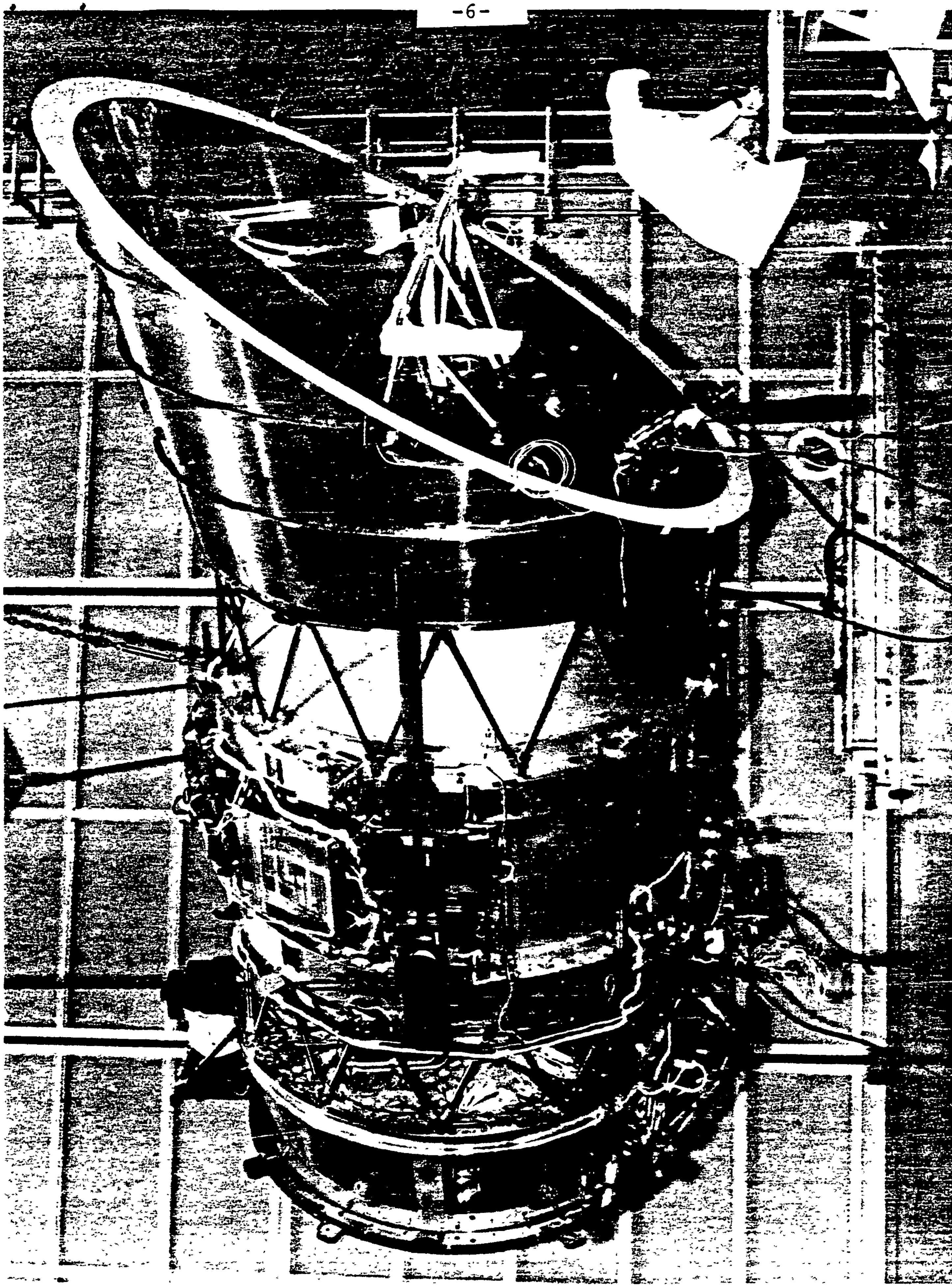
The Dutch Additional Experiment was built by the Space Research Laboratory of the University of Groningen, with TPD-TNO as subcontractor.

IRAS TELESCOPE AND CRYOGEN SYSTEM

The heart of the IRAS satellite is its telescope, designed to detect infrared radiation in the region of 8 to 119 microns. It will observe emissions of infrared energy as faint as one million-trillionth of a watt per square centimeter.

Since infrared radiation is heat, the IRAS system must be kept cooled in order to detect the faintest astronomical infrared emissions above the level of heat radiated by the instrument itself.

On orbit, the detector package at the focal plane of the telescope will be kept at the extremely cold temperature of 2 K (-455 F).



IRAS TELESCOPE U' 'GOING CHECKOUT

Maintenance of that low temperature -- limiting heat flow into the focal plane to less than a tenth of a watt -- is central to the telescope's operation, and represents the satellite's major engineering challenge. The telescope's life-time is limited by the rate at which the cryogen is boiled off into space.

The cooling vessel, a dewar, is doughnut-shaped and surrounds the telescope. It contains 475 l (125 gal.) of superfluid helium. Superfluid helium is an extremely good conductor of heat, about 1,000 times better than silver, the best metallic conductor. At zero gravity, it will exist as a superfluid film on the walls of its container, maintaining the entire 1.8- by 1.8-m (6-ft. by 6-ft.) tank at a uniform temperature.

A 3.8-cm (1.5-in.)-diameter porous plug made of sintered stainless steel is mounted in the upper end of the main cryogenic tank. It acts as a stopper to prevent superfluid helium from escaping in the zero-gravity environment on orbit. The plug, however, allows vaporized helium to be vented off into space, at an average rate over the lifetime of the mission, of about 300 grams (11 ounces) per day. The telescope system weighs 810 kg (1,785 lb.).

The telescope and surrounding superfluid helium tank are mounted within an evacuated main shell. They are supported within the shell by a harness of nine straps made of fiberglass-epoxy. Insulating the tank from the main shell are several shields cooled by the cryogen exhaust and 57 layers of aluminized Mylar and Dacron net.

In addition to the telescope's required cold temperature, it must be protected from direct sunlight, and stray light, which is heat, from earth, the moon and the sun.

The chamfered, conical telescope sunshade, its interior mirrored with gold plating, limits the heat flow to the aperture by reflecting solar and earth infrared radiation outward toward space.

A large, multilayered insulating blanket separates the spacecraft bus from the dewar shell bottom, minimizing heat flow from the spacecraft electronics to the cooling vessel. The telescope electronics boxes are mounted on trusses outside the dewar and blanketed with insulating material to further reduce the heat that reaches the dewar.

The telescope aperture cover, cooled by supercritical helium, will remain on the telescope during ground operations and for approximately the first week in orbit. The cover protects the telescope from contamination by outgassing from the satellite. When the outgassing of the spacecraft has declined to an acceptable level in orbit, a pyrotechnic system will eject the cover. After another week of checkout and calibration of the telescope, the satellite will become operational.

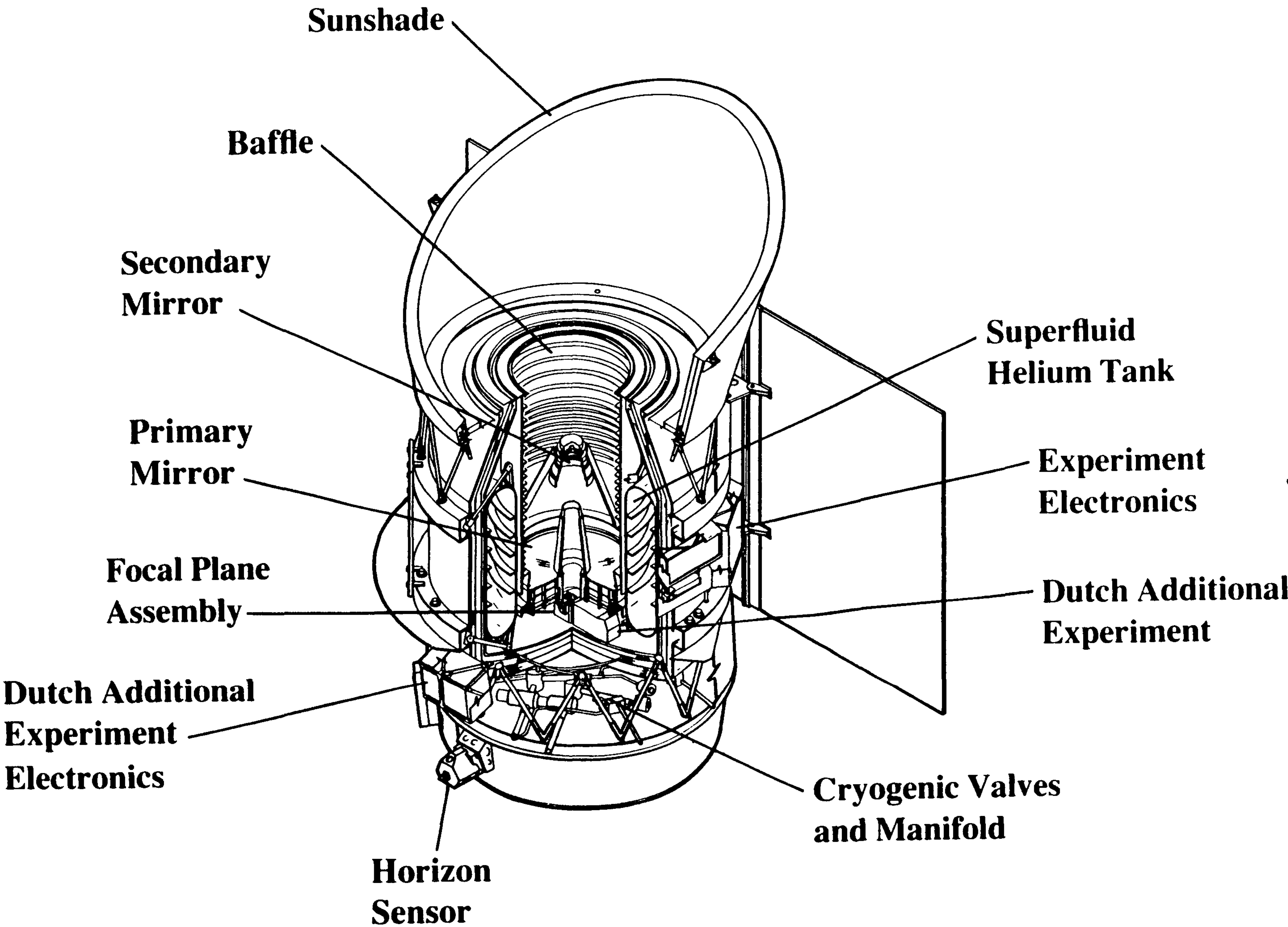
The telescope line-of-sight must remain at an angle greater than 60 degrees from the sun, 20 degrees from the moon, and 88 degrees from earth's limb (the lighted edge of the planet's disk) to prevent their infrared radiation from getting into the telescope.

The telescope is an f/9.6 Ritchey-Chretien type, with a 57-cm (22.4-in.) effective-aperture primary mirror made of lightweight beryllium, an effective field of view of 30 arc-minutes, and a 5,500-mm focal length.

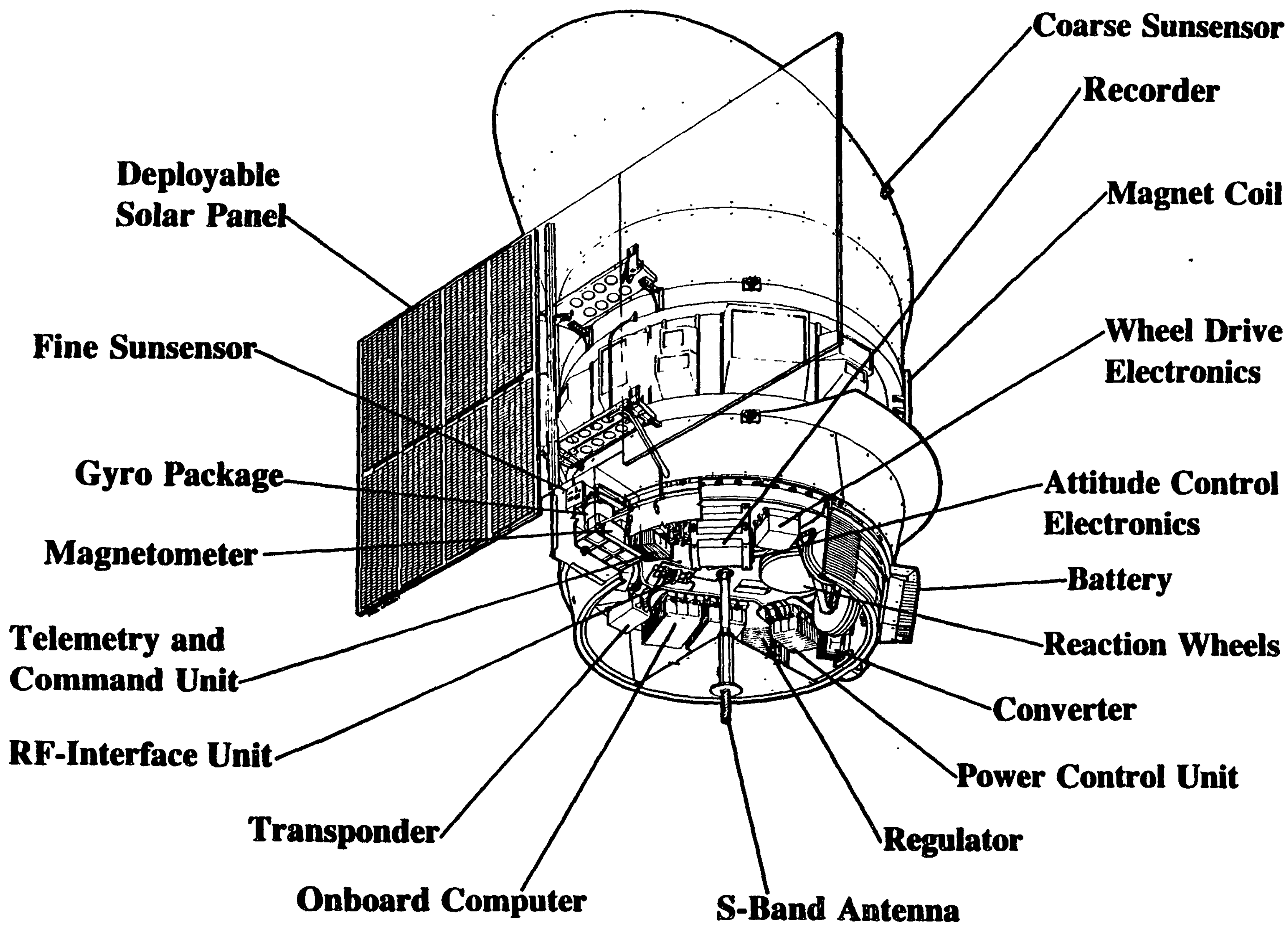
Sixty-two rectangular detectors, varying in size from 7.2 by 1.2 mm (0.28 by 0.05 in.) to 7.5 by 5 mm (0.29 by 0.19 in.), comprise the focal-plane array at the base of the telescope. The detectors observe in four wavelengths of infrared: Infrared Band 1 uses 15 silicon-arsenide detectors and observes in the spectral range of 8.5 to 15 microns; IR Band 2 uses 16 silicon-antimonide detectors and has a spectral range of 19 to 30 microns; IR Band 3, using 16 germanium-gallium detectors, observes from 40 to 80 microns; and IR Band 4 uses 15 germanium-gallium detectors and has a spectral range of 83 to 119 microns.

As the telescope scans the sky, the detectors will record infrared emissions that cross their field of view. Sources move from the top to the bottom of the focal plane as the telescope scans the sky. The detectors are geometrically arranged so that each source encounters two detectors in each of the four wavelength bands, producing a characteristic "double hump" signature for a point source in each channel. Each area of the sky is scanned four times, yielding eight possible detections for each source.

To confirm that a detected source is an astronomical infrared object, and not a disturbance like a cosmic ray, the source must be successfully observed by detectors on at least three of the four detection opportunities during the first two survey scans, which take place on consecutive orbits. That confirmation procedure ensures that the infrared emission source is not an object such as an earth satellite. For further confirmation, and proper identification of slower-moving objects such as comets and asteroids, the same area of the sky will be observed approximately a week later with two more scans, and the same three-out-of-four rule will be applied. At the request of asteroid astronomers, a special processing program has been developed to discriminate asteroids from other space objects in the final processing.



SPACECRAFT COMPONENTS



SPACECRAFT COMPONENTS

ATTITUDE CONTROL

IRAS' attitude control is a digital subsystem that will point the satellite (in absolute coordinates) with an accuracy of 30 arc-seconds (1/120 degree). (Precise reconstruction of the satellite's pointing direction after data are taken are expected to provide pointing data to within 20 arc seconds.) Relative pointing accuracy -- control and determination of relative positions over a small area of the sky -- is expected to be on the order of a few arc-seconds.

Six coarse sun sensors, with a field-of-view of 126 degrees surround the satellite to ensure sun acquisition during the initial part of the flight. A horizon sensor with a field of view of about 60 degrees is located at the base of the spacecraft. Both sensors serve to keep the telescope aperture continually pointed away from the earth and sun. Two fine sun sensors, with a field of view of about 64 degrees, are mounted perpendicular to one another beneath the solar panels. Fine attitude control for slewing, scanning, pointing and raster scanning is maintained by fine sun sensors and three orthogonally mounted gyros.

In addition, slit-type star sensors share the focal plane with the detectors. As part of the attitude control subsystem, they scan over on chosen reference stars to determine absolute calibration of telescope pointing, and are used to determine the telescope line-of-sight during a survey scan.

A magnetometer also contributes to the attitude control system. It senses the local direction of the earth's magnetic field, and determines which combination of three magnetic coils should be used to transfer accumulated angular momentum from three reaction wheels (that keep the spacecraft pointed in the desired direction) to the earth, using earth's magnetic field to absorb the momentum.

ONBOARD COMPUTER AND DATA STORAGE

A primary computer and an identical back-up control IRAS and transfer data collected by the satellite to the tape recorder. The primary computer is responsible for storing and executing the daily observation program, and controls the satellite's attitude, data handling, command system and data storage.

Each is comprised of a central processor unit, input/output unit, oscillator and clock driver circuits and a 32,000-word memory. The entire 64-kiloword memory can be used by each computer.

Two tape recorders can each store up to 450 million bits of information acquired by the telescope. Data is played back to the IRAS ground station at Chilton, England, at a rate of about 1 million bits per second.

COMMUNICATIONS

IRAS carries two redundant NASA Standard Transponders, each consisting of a receiver and transmitter. Both receivers are on continuously so that emergency commands may be sent from any of NASA's Satellite Tracking and Data Network (STDN) stations, operated by Goddard Space Flight Center.

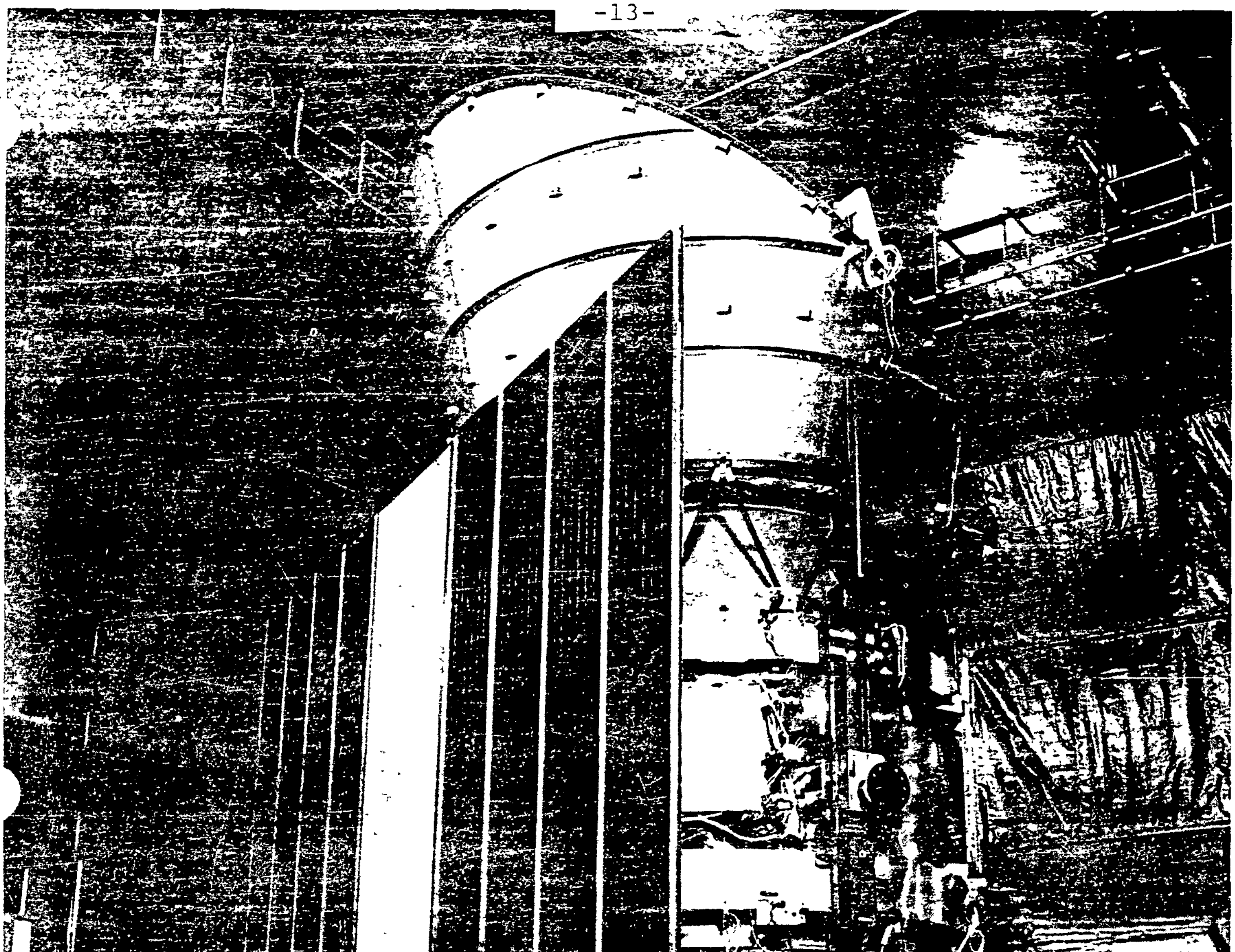
Only one transmitter will be operated at a time, with the second on standby. The transmitter will normally operate twice a day when IRAS passes over the ground station at Rutherford Appleton Laboratory in England.

A 12-m (40-ft.) dish antenna at the ground station will transmit commands and receive IRAS data. If a ground-station emergency occurs, data may be transmitted to any STDN station.

IRAS' 18-cm (7-in.) antenna, which protrudes about 50 cm (20 in.) from the base of the spacecraft, is a quadrifilar helix (a four-strand spiral) similar to the antennas used by the Viking orbiters to communicate with the Viking landers on the surface of Mars.

IRAS transmits two sets of data simultaneously on 2253 MHz: Tape-recorded data from the telescope is transmitted at 1,048,576 bits per second; engineering and housekeeping information on the satellite operations is sent at 4,096 bits per second. The signal is pulse-code and phase modulated. There is one telemetry and command unit on the satellite and one coupler-diplexer-switch unit.

The transponder output power is one watt. Commands from the ground station are sent at 10 watts. The uplink commands are sent at 2074.6375 MHz, and are pulse-code and phase modulated.



COMPLETE IRAS SPACECRAFT ASSEMBLY

MISSION OPERATIONS

After launch and a two-week in-orbit checkout, IRAS will begin its sky survey. The Operations Control Center is at Rutherford Appleton Laboratory, Chilton, England, 20 miles south of Oxford.

IRAS will complete 14 orbits of the earth each day. Twice a day the satellite will transmit data to the antenna at Chilton and the commands for the next period will be uplinked to the satellite. The team at Chilton will process part of the data to determine satellite condition and to determine if the survey operations should be altered to suit any change in conditions. The full data set will then be transmitted via satellite to JPL for complete processing.

Two basic data-processing functions will be carried out during the project lifetime:

Gather the infrared data and generate a working survey data base and Additional Observation data tapes for the scientific users. (Additional Observations are scientific observations of specific, interesting objects and are separate from the all-sky survey.) This function is performed primarily at JPL.

Generate the final data products for the project -- the infrared sky maps and infrared source catalog. This function is carried out primarily at JPL.

Two mission phases have been defined:

The Mission Operations Phase begins with launch of IRAS and continues until control of the satellite is terminated.

The Final Data Products Phase begins when the Joint IRAS Science Working Group determines that the working survey data base meets the group's requirements, or when the acquisition of survey data ends.

The Mission Operations Manager has responsibility for all mission operations, and reports to the co-chairmen of the Joint IRAS Project Executive Group.

A Resident Astronomer, located at Chilton, is the science team's contact with mission operations. He is responsible for ensuring that the scientific objectives of the mission are pursued to the limit of the satellite's capabilities.

Teams involved in mission operations at Chilton include the Survey Strategy Task Team, the Scientific Performance Evaluation Team, Survey Planning and Analysis Team, physically resident at JPL, Operations Analysis Team, Operations Sequencing Team, Chilton Science Support Team, Spacecraft Operations Support Team, Telescope Operations Support Team, DAX Operations Support Team, and the Chilton Operations Support team.

MANAGEMENT

JPL manages the U.S. portion of the project for NASA's Office of Space Science and Applications, and will perform the data processing. NASA's Ames Research Center was responsible to JPL for managing development of the telescope system.

The Delta Project Office at Goddard Space Flight Center provides the Delta launch vehicle, and Kennedy Space Center is responsible for the launch at Vandenberg Air Force Base.

The Netherlands is responsible for design, manufacture and testing of the spacecraft and integration, system testing and launch preparations of the complete satellite. The Netherlands Aerospace Agency (NIVR) has supervised the task, which was executed by an industrial consortium consisting of Fokker and Hollandse Signaalapparaten.

The establishment of ground operations in England was coordinated by the Dutch National Aerospace Laboratory under a subcontract from ICIRAS.

The United Kingdom, with funding through the Science and Engineering Research Council, provides satellite tracking, data acquisition and other ground support, including orbit determination and prediction, generation of observation program, data distribution and archiving, and preliminary data analysis. The control center and the tracking station are located at Rutherford Appleton Laboratory at Chilton, near Oxford.

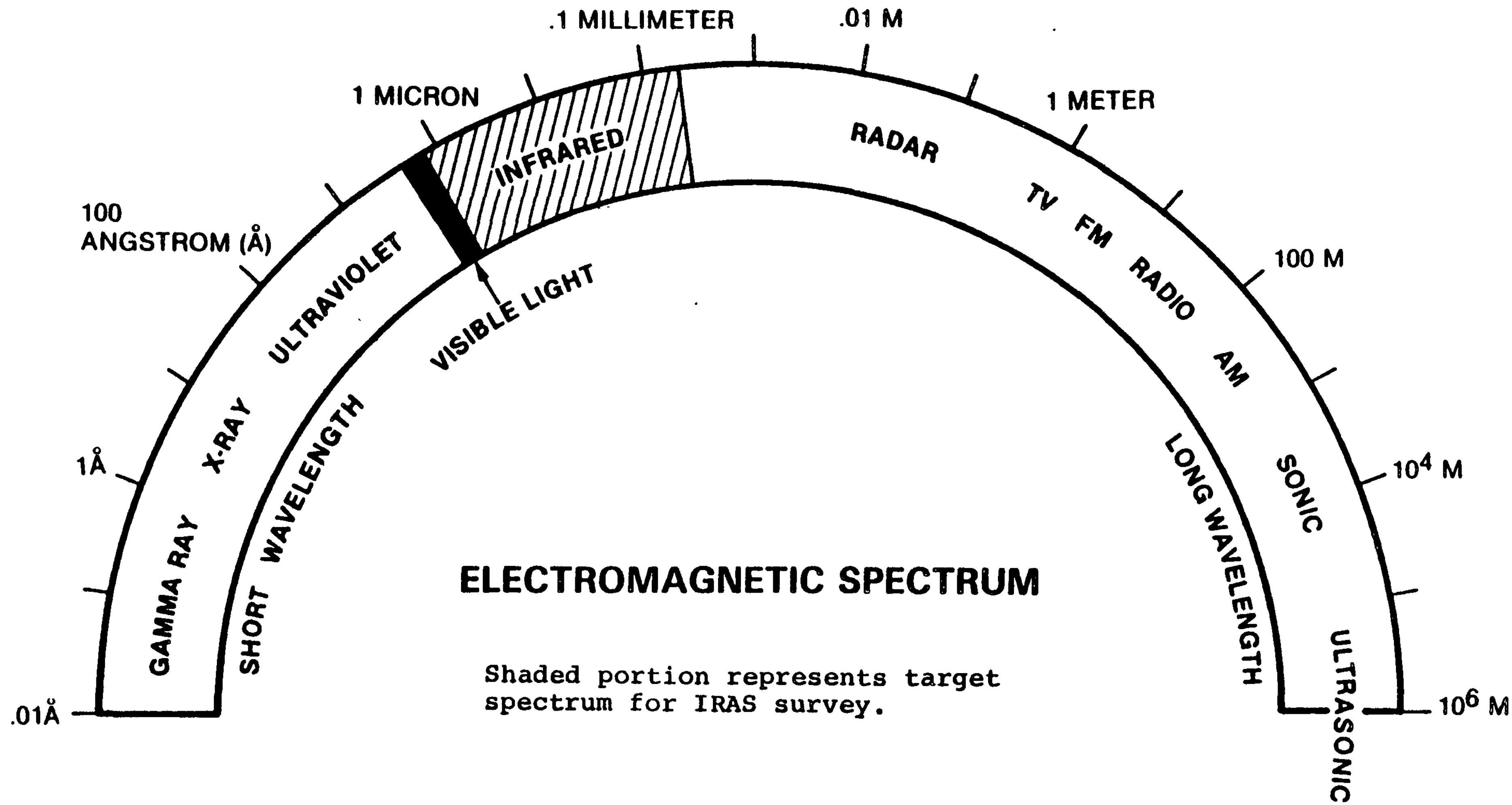
The joint project is managed by a Joint IRAS Project Executive Group (JIPEG), cochaired by JPL and NIVR program directors. Members of JIPEG are representatives of the participating scientists, industries and institutes.

The scientists are organized as a Joint IRAS Science Working Group (JISWG), cochaired by the U.S. and Netherlands principal investigators who are also members of JIPEG.

SCIENCE RATIONALE

The wavelengths of radiation from stars and other objects in space depend on the object's temperature -- the lower the temperature, the longer the wavelength at which it radiates most strongly. Thus the sun radiates mostly in the visible range of the spectrum while much cooler stars, planets and spacecraft radiate mainly in the infrared.

Optical telescopes are used primarily to observe stars that shine in the relatively short wavelengths of the visible range of the spectrum, generally higher than about 6,000 K (10,000 F).



ELECTROMAGNETIC SPECTRUM

Shaded portion represents target spectrum for IRAS survey.

But many other objects in the universe have much lower temperatures; the wavelengths at which they radiate, therefore, are longer, and cannot be seen, with a few exceptions, with an optical telescope looking through the atmosphere. Objects that radiate at temperatures from a few tens of degrees Kelvin to a few hundreds of degrees Kelvin appear to be very numerous. IRAS should be able to find many cool, dark stars, as well as many brighter stars, hidden by clouds of cool dust that render them invisible because starlight cannot penetrate the dust.

Infrared radiation, however, passes through the dust clouds, because its wavelengths are greater than the size of the dust.

Objects that are expected to be visible to the IRAS telescope include:

* Center of the galaxy: The center of the Milky Way, hidden by large amounts of dust. Although it contains about one millionth of the galaxy's volume, it radiates one-tenth of the energy of the entire galaxy. Astronomers don't know why, but expect IRAS to provide data that will help them to answer the question.

* H II regions: Young, hot, type O and B stars heat large clouds of hydrogen atoms that are then broken apart into their component protons and electrons. They are, therefore, ionized (called H II by astronomers). The dust clouds associated with those stars radiate strongly in the infrared.

* Birth of stars: Cool clouds of dust are associated with the H II regions. Theory holds that gravitational collapse causes the clouds to coalesce and form new stars. Once the new stars are massive enough and hot enough, thermonuclear reactions begin and they glow in the visible portion of the spectrum. But during early stages of their evolution, when they are cooler, they radiate mainly in the infrared.

* Death of stars: As stars exhaust their nuclear fuel, near the end of their lives, they eject large clouds of dust. Visible light from the dying star is absorbed by the shell of dust surrounding it. The energy is then reradiated in the infrared.

* Molecular clouds: Floating in space between the stars are giant, dense clouds that contain a huge variety of hydrogen and carbon-based molecules. Because they contain large quantities of heated dust, the molecular clouds also radiate in the infrared.

* Extragalactic objects: Far beyond the Milky Way galaxy where we reside lie millions of other galaxies and many extremely unusual objects. Quasars, for example, and the nuclei of some galaxies are extremely bright in the infrared -- up to 10,000 times brighter than the nucleus of the Milky Way.

* Astronomers predict that, since IRAS will cover the entire sky with a sensitivity much greater than any previous survey, it may find quite unexpected classes of objects.

IRAS SURVEY STRATEGY

The primary objective of IRAS is to conduct a survey of the entire sky in the infrared region of the spectrum.

The specific strategy by which four or more scans will be made across each portion of the sky is a complex exercise in geometry affected by such factors as proton activity in the Van Allen belts, and infrared radiation from the earth, the moon and the sun.

Planning for the orbit strategy both before and after launch is done at JPL by the Survey Planning and Analysis Team. Implementation of the strategy and control of the satellite are carried out at the Operations Control Center at Chilton, England.

Project strategists plan to complete the survey about seven months after launch. Available time between survey observations will be spent resurveying and observing specific infrared objects.

As IRAS orbits the earth, the telescope looks outward, tracing a track one-half-degree wide across the sky.

IRAS mission planners use a system that divides the sky into segments called "lunes." Each lune covers 30 degrees of the sky. A lune is the area of a sphere included between two meridians of ecliptic longitude -- a slice out of the sky that is like a pair of great circles on the surface of earth.

The strategy is complicated by the changing positions of the sun, the moon and the earth. As time passes and the earth moves around the sun, the orbital track will shift across the sky. Because the earth is not a perfect sphere, however, its gravity can be employed to cause the orbit to track the sun (about one degree each day), a so-called sun-synchronous orbit. Thus the sun can be kept from unduly interfering with the astronomical observations.

Segments of the lunes are scanned by the telescope on part of each orbit. The scan begins and ends at the boundaries of the lune being observed, then begins again at the boundary of the corresponding lune on the other half of the orbit.

During later orbits the same track is scanned again. The scans overlap, until four separate scans of each point of the sky have been completed.

While IRAS will complete 14 orbits of earth each day, it cannot make observations during all portions of all orbits. The South Atlantic Anomaly is a region in space, centered above the South Atlantic Ocean, where the Van Allen radiation belts dip close to earth. Energetic protons trapped in the Van Allen belts strike the satellite during its passage through the region, creating noise that interferes with observations.

So sky-survey observations are planned during only nine of the 14 daily orbits. On the five orbits when IRAS flies through the most intense portion of the anomaly region it will perform additional observations in the useful portions of those orbits.

THE DUTCH ADDITIONAL EXPERIMENT

In addition to the infrared telescope, IRAS carries a set of three complementary instruments, built in the Netherlands and called the Dutch Additional Experiment (DAX). The package is mounted in the focal plane of the primary telescope.

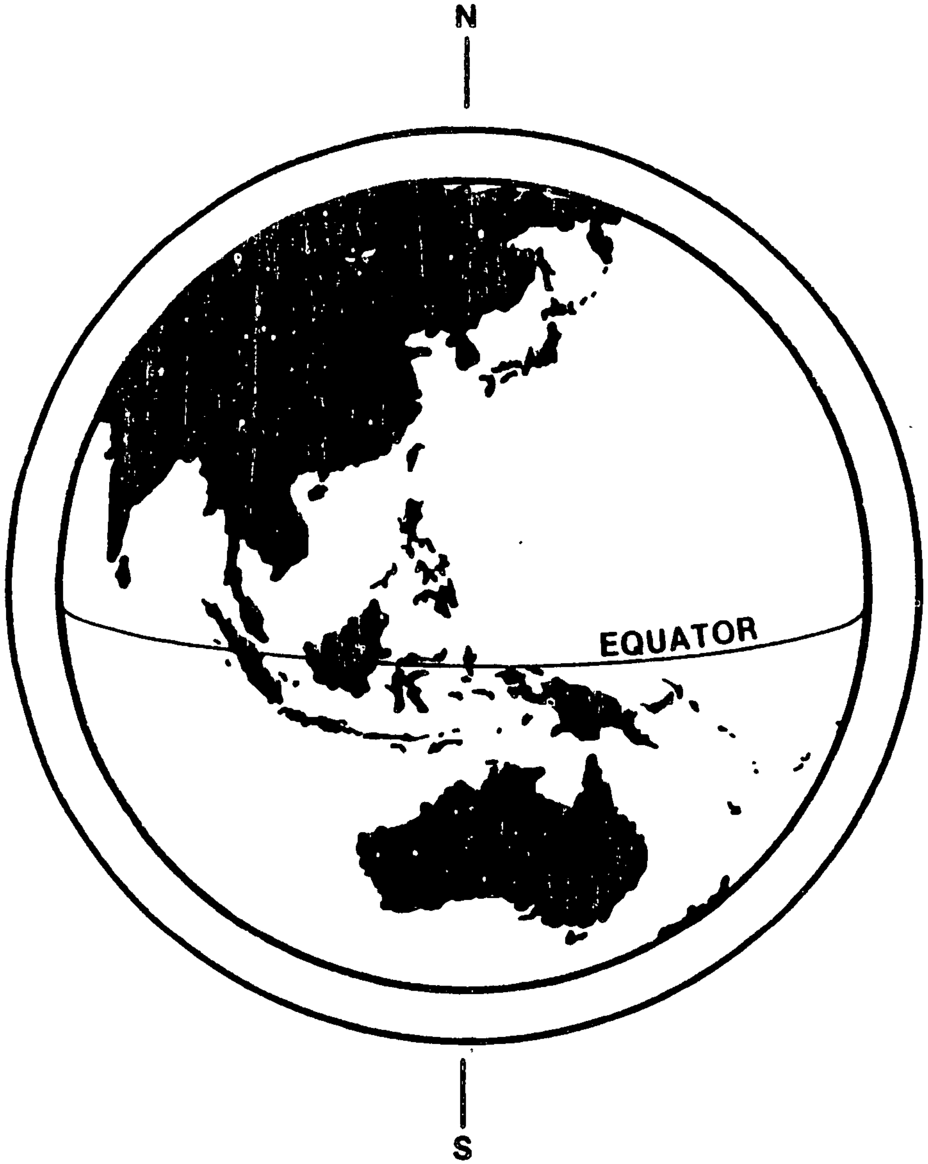
The three instruments are a low-resolution spectrometer, a long-wavelength photometer and a short-wavelength-channel photometer. They are designed to complement the survey telescope and to meet a broad range of scientific objectives.

The low-resolution spectrometer is comprised of five detectors that will acquire spectra of strong infrared point sources observed by the main telescope in the wavelength range from 7.4 to 23 microns. Data from the instrument will aid in classification of infrared sources.

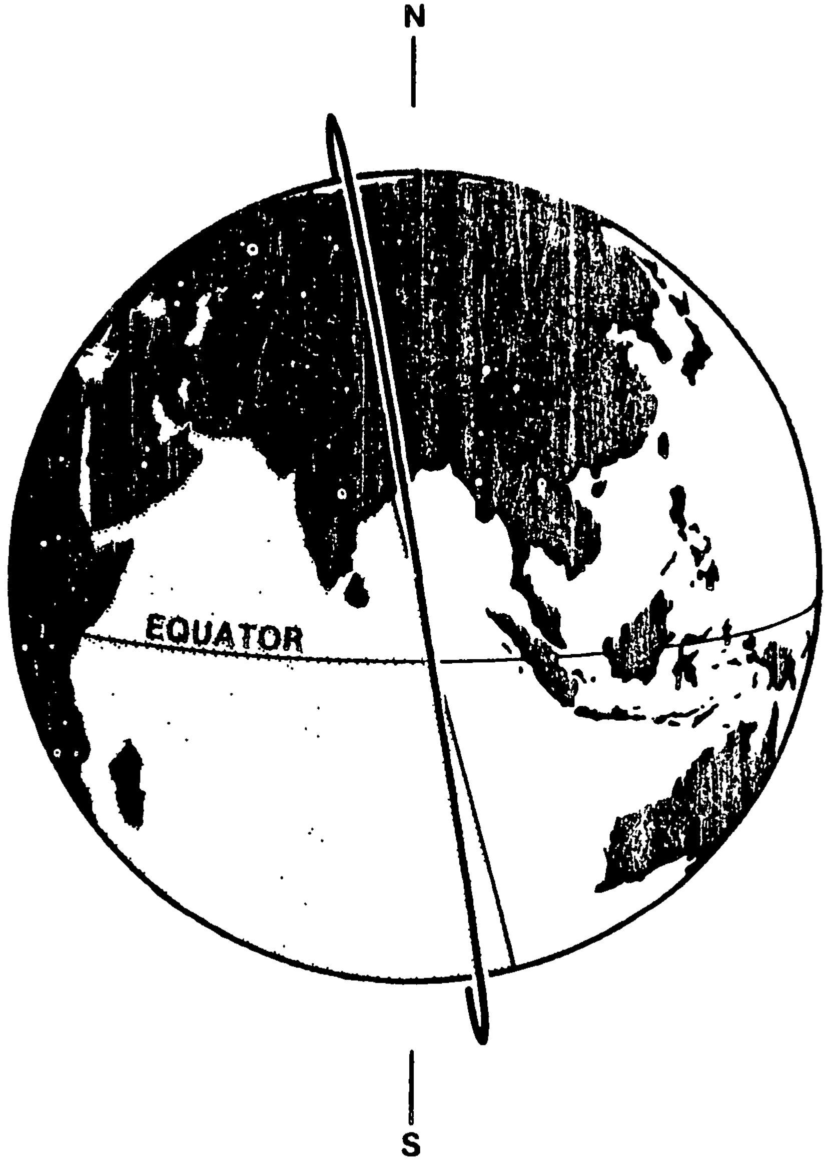
The detector outputs are sampled and recorded continually. The data-processing system on the ground will use point-source detections from the primary-telescope data to find the exact locations of spectra in the data stream from the low-resolution spectrometer. The low-resolution spectrometer is used in combination with the main telescope.

The long-wavelength photometer employs two detectors -- chopped photometry channels that allow both absolute and differential photometry of the infrared sources. The two detectors have three apertures. One aperture cover opens and closes 15 times a second. As it closes, it shuts out all radiation, providing a zero base for the detectors to derive an absolute reading on the intensity of observed infrared emissions. The two other apertures operate so they will not count the same particle twice, while reading two separate areas of the sky. The readings aid in mapping intensity and other characteristics of infrared sources.

TYPICAL IRAS ORBITS



FIRST ORBIT



ORBIT 3 MONTHS LATER AFTER ITS SLOW PRECESSION (ROTATION) TO KEEP THE TELESCOPE'S VIEW 90° FROM THE SUN AND SUNLIGHT ON THE SOLAR PANELS

The instrument is designed to map infrared sources that radiate in two wavelength bands simultaneously -- from 41 to 62.5 microns, and from 84 to 114 microns. The long-wavelength photometer cannot be used while the survey telescope is operating.

The short-wavelength-channel photometer uses a single detector that scans at the survey rate, and covers the wavelength band from 4.1 to 8 microns. It is designed to obtain information on the distribution of stars in areas of high stellar density. It will provide statistical data on the number of infrared sources.

In 1977 The Netherlands Committee for Geophysics and Space Research committed the Space Research Laboratory at the University of Groningen to design, build and operate the DAX. The instrument's optical and mechanical systems were designed and built by the Netherlands Institute of Applied Physics at Delft. The electronics were built by Hollandse Signaalapparaten at Hengelo. Systems management, design of the electronics, unit testing and calibration were done at the University of Groningen.

PLASMA INTERACTION EXPERIMENT

An experiment aimed at helping designers of future space power systems is attached to the second stage of the Delta launch vehicle that will carry IRAS to orbit.

It is called Plasma Interaction Experiment II, and will provide detailed information on the electrical interaction of space plasma with high-voltage spacecraft surfaces. Engineers believe a number of spacecraft irregularities or failures may have been caused by the interaction between plasma and high-voltage surfaces in the past.

PIX II is the second experiment to investigate the effects of space plasma on solar arrays, power-system conductors, insulators and other exposed spacecraft components. Engineers expect the information gained from PIX II to enable them to develop reliable, large, high-voltage (100 volts or higher) power-generation systems for future applications.

The 45-kg (99-lb.) experiment will remain with the second stage of the Delta launch vehicle and remain in orbit at an altitude of 640 km (400 mi.). It consists of a 50-by-38-cm (20-by-15-in.) solar array, a spherical Langmuir probe, and an electronic package containing electrometers, a high-voltage power supply, and a power-control unit and battery.

INFRARED ASTRONOMY

On a diagram of the electromagnetic spectrum, infrared stretches from the near edge of radio waves, at 1,000 microns (1 millimeter) where the corresponding temperatures are lowest, to the edge of red light at 1 micron, the longest wavelength in the visible range, where temperatures become high enough to cause objects to glow in the visible range. Astronomers divide the infrared into three general regions: near, middle and far refer to the specific wavelength's distance from visible (red) light.

Everything emits infrared radiation. As an object is heated it begins to radiate at the longest-wave infrared while still quite cold -- only a few degrees above absolute zero -- and continues to radiate, at ever-shorter wavelengths, as the temperature increases.

When the temperature gets high enough, the object glows in visible light. At even higher temperatures it radiates strongly in the ultraviolet.

Astronomers believe infrared radiation is a major portion of the energy budget of the universe.

But a basic problem exists: earth's atmosphere absorbs infrared from earth's surface and incoming infrared from space. The atmosphere also emits its own infrared radiation. Those effects make it difficult for astronomers to measure infrared sources in space.

Infrared reaches the surface of earth in only a few narrow wavelength bands or windows at wavelengths of 1.1 to 1.4 microns; 1.5 to 1.8 microns; 2.0 to 2.4 microns; 3.0 to 4.0 microns; 4.5 to 5.0 microns; 8 to 13 microns; 16 to 23 microns; 30 to 40 microns; 300 to 400 microns; and about 700 microns to the beginning of radio frequencies (above 1 millimeter). The major component of the atmosphere that restricts infrared observation is water. Thus telescopes at very high, dry altitudes can measure the radiation in the 16 to 23, 30 to 40 and 300 to 400-micron ranges. The Mauna Kea observatory in Hawaii, at about 4,300 m (14,000 ft.) elevation, is a favorite site for infrared astronomy, because it is above most of the atmosphere and, therefore, most of its water.

Infrared observations from space with rockets or satellites provide astronomers with a clear, unobstructed view of regions they have been unable to observe before. Vast clouds of cool gas and dust lying between the stars, and in many cases surrounding them, absorb the visible light from those stars. The ability of electromagnetic radiation to pass through a dust cloud depends on the size of the dust particles and the wave-length of the radiation. If the particles are about the same size as the radiation, the radiation is absorbed or reflected back in the direction from which it came. For example, the wavelengths of visible light are shorter than a micron.

The dust particles in space are about the same size. So the dust absorbs the light. When the wavelength is greater than the particle sizes, the radiation can pass through the dust clouds.

Infrared has significantly longer wavelengths than visible light; therefore, infrared radiation can pass through the dust clouds.

Although infrared astronomy has thus far been limited primarily to studying objects discovered at other wavelengths, such as visible and radio, it is producing major contributions to the understanding of many areas of astrophysics. In observations of the Milky Way, those contributions include the origin, constitution and replenishment of interstellar matter, both gas and dust grains, the questions of star formation, and the energy balance of ionized hydrogen regions and molecular clouds.

Infrared observations indicate that many extragalactic sources, both normal galaxies and the more peculiar, explosive galaxies, emit copiously in infrared. In fact, many extragalactic objects emit the bulk of their luminosity at infrared wavelengths. Understanding how the energy is produced is among the most pressing of current astrophysical problems.

While astronomers know from earlier studies that many astrophysically interesting objects are producers of infrared energy, they do not know how significant the infrared portion of the spectrum is to the total energy budget of the universe.

Understanding the total energy budget is paramount to understanding the origin and evolution of the universe. The IRAS survey will provide data to assist in that understanding.

Earlier infrared surveys included the Caltech survey at 2 microns and the Air Force Cambridge Research Lab survey at 4, 11, 20 and 30 microns. Those surveys were dominated by sources essentially stellar in nature and were not sensitive enough to ensure discovery of all important classes of infrared emitters. A third survey, called the Far Infrared Space Experiment, has surveyed one-fourth to one-third of the sky at 100 microns, at a sensitivity about one-tenth that predicted for IRAS. None of the data from that survey has been published yet.

In Holland, the Space Research Laboratory of the University of Groningen has carried out infrared research using stratospheric balloon platforms at an altitude of 30 to 35 km (18 to 22 mi.). About two balloon missions are flown each year. From 1969 to 1974, the Inframat program provided infrared survey scans in the 20- to 200-micron range using a photometer. Inframat was followed by BIRAP (Balloon Infrared Airborne Platform) -- a 60-centimeter (24-inch) telescope and a four-band chopped photometer measuring molecular clouds and H II regions at 20 to 200 microns. Since 1980, a two-band photometer has been used in the 70- to 100-micron band.

In 1982, the Space Research Laboratory of Groningen experimented with a balloon-borne, cryogenic Sabry-Perot spectrometer that measured at 63 microns.

Only a cooled space telescope with low background environment allows a high-sensitivity, all-sky survey in a seven-month period. Such a sky-survey mission presents a unique opportunity to accumulate a wealth of astrophysically important information about the infrared sky and provide a basis for the next generation of astronomical research.

An important part of the survey lies in the Milky Way galaxy's relative transparency to infrared radiation, thereby getting around optical astronomers' difficult problem of interstellar extinction of starlight by dust.

The explanation of the origin of interstellar dust has been one of the major contributions of infrared astronomy. Interstellar dust particles are about the size of smoke particles -- smaller than one micron. The material is formed in the interiors of stars by nucleosynthesis. It is composed of all particles heavier than helium. The material is ejected from old stars. The process is thought to dominate the resupply of interstellar material with fresh matter. Through infrared observations it is possible to determine how much matter a star loses, adding that amount to the dust in interstellar space. The IRAS survey is expected to detect a significant fraction of all such objects in the Milky Way.

Astronomers can, therefore, envision actually measuring the rate of ejection of matter into the interstellar medium from dying stars. This, in turn, is related to the total mass of the universe.

Recent studies indicate that silicates are one of the dominant constituents of interstellar dust. Appropriate wavelength selection for the survey will enable astronomers to map the distribution in the galaxy of the silicates.

The Becklin-Neugebauer Object in Orion is the prototype of a class of infrared objects thought to be protostars, that is, interstellar gas and dust clouds that are collapsing to form new stars. IRAS should be able to detect all such objects in the Milky Way.

Calculations suggest that the IRAS survey could detect protostellar objects as small as the sun (one solar mass) over a substantial fraction of the Milky Way. Astronomers hope, with those results, to measure directly the rate of star formation in the galaxy.

Regions of ionized hydrogen are, as the nearby presence of very young stars demonstrates, the locations of recent or ongoing star formation.

-more-

Ionized hydrogen consists of protons and separate electrons, broken apart by the intense radiation from nearby hot stars. Astronomers say clouds of ionized hydrogen can exist only in the vicinity of hot stars -- and usually surround them -- because only hot stars produce photons with the energy to break the bond between the proton and electron.

The Trapezium region of Orion is called by astronomers a fairly ordinary H II region, but it is important because it is close to the solar system. All regions of that kind, to the distance of the Large and Small Magellanic clouds, could be detected in the IRAS survey. The Large Magellanic Cloud is 50 kiloparsecs (163,000 light years) from the sun; the Small Magellanic Cloud is 60 kiloparsecs (196,000 light years) away. (A parsec is 3.262 light years; a kiloparsec is 1,000 parsecs.) All H II regions identified in radio-astronomy surveys of the galactic plane should be detectable at all IRAS survey wave-lengths. That includes giant H II regions such as the objects called M17, W51 and Sgr B2. Sgr B-2, for example, is probably the most massive cloud in the Milky Way, with 3 million solar masses concentrated in a radius of 3 parsecs (9.8 light years).

More species of interstellar molecules have been detected in Sgr B-2 than in any other galactic cloud. (Sgr is astronomers' abbreviation for the constellation Sagittarius -- the archer -- in the southern sky.)

Radio-astronomy observations in recent years have shown that vast clouds of molecules are common in the Milky Way galaxy. They are composed of a variety of molecules, from molecular hydrogen, the most ubiquitous, to carbon monoxide, water, ammonia and a wide variety of simple organic molecules such as formaldehyde. The molecular clouds take the form of dust and gas.

Many of the clouds are cold (temperatures less than 10 K or -441 F), and may be in the earliest stages of collapse. With the IRAS all-sky survey, astronomers will be able to observe many of those collapsing clouds, as well as all the larger molecular clouds in the Milky Way that are as luminous as OMC-2. OMC-2 is a cloud of molecular hydrogen behind the Orion Nebula that is invisible to optical astronomers, but visible in infrared. It appears to be a region where stars are in the process of forming.

Since all the important known infrared emitters in the Milky Way will be detected over virtually the entire galaxy, the survey will add significantly to understanding the over-all structure and evolution of the galaxy.

Since the survey will detect stars over the entire Milky Way galaxy, it should allow a determination of galactic structure from the distribution of those stars. The IRAS survey will locate nearly all regions of ongoing star formation in the galaxy, providing a better understanding of the current evolution of the galaxy.

The survey will also provide a measurement of the total infrared luminosity of the Milky Way, to permit comparison with infrared emission from other galaxies.

In extragalactic astronomy the importance of the IRAS all-sky survey is that it will allow astronomers to see more objects at greater distances than before. To the surprise of astronomers, many galaxies remain active, forming more new stars than the calculations show they should. Infrared appears to be a tracer for star formation in galaxies; it should allow astronomers to pinpoint star formation -- how common it is and how active. From that information, it is only a step to the question, why do galaxies evolve the way they do?

The most far-reaching and important aspect of the IRAS all-sky survey may be the discovery of new classes of objects whose energy is radiated nearly entirely at infrared wavelengths.

A few such objects have been discovered in the previous infrared surveys, and those sources have proven extremely interesting on further investigation. One such object, given the designation IRC+10 216, was discovered in the Caltech 2-micron survey.

It appears to be a carbon star, a star in the process of dying, that has shed a massive layer of dense dust that surrounds the core star. The cloud is so dense that it blocks the sunlight coming from the star.

Another type of new object, seen widely spread across the galaxy in the 10- and 20-micron wavelengths by the Air Force Cambridge Research Lab's survey, is what astronomers call protostars, clouds of dust and gas that are collapsing to form new stars.

The previous infrared surveys, however, have not been sufficiently sensitive to demonstrate that all the important types of infrared emitters have been discovered. Any important, but as yet undiscovered, sources of infrared radiation would certainly be detected in the IRAS survey, unless they were exceedingly cold objects.

The IRAS sky survey will have the sensitivity to detect a broad variety of objects of all kinds, from small, dim, dwarf galaxies up to large galaxies with billions of stars at a distance of 10 megaparsecs (32.6 million light years).

Repeated scanning could increase the survey sensitivity by a factor of 10. It therefore seems probable that very few objects that consist of cool, luminous matter almost anywhere in the universe will go undetected. Certainly all important infrared contributions in the universe will be detected.

THE DELTA 3910

The first stage is composed of a liquid propellant rocket vehicle that is thrust-augmented by solid propellant motors. This rocket vehicle is 2.4 m (8 ft.) in diameter and 22.4 m (73.4 fT.) long, with a propellant capacity of 80,300 kg (176,660 lb.) of RJ-1 and liquid oxygen. This rocket vehicle is powered by the Rockwell International Rocketdyne RS-27 engine derived from the Saturn IB H-1 engine. The turbopump-fed engine develops 912,000 Newtons (205,360 lb.) thrust at liftoff, and burns to propellant depletion about 228 seconds after liftoff at an altitude of about 85 km (57 mi.). Solid propellant rocket motors for thrust augmentation are attached at the base of the first stage on the Universal Boattail (UBT) engine-section structure. This is structurally designed and thermally insulated to carry up to nine Thiokol Castor IV solid motors.

Each of the Castor IV motors develops 376,500 N (84,790 lb.) thrust at ignition and burns for 57 seconds. Separation sequence can be varied depending upon the mission. Six motors will be ignited on the pad and the remaining three 60 seconds later. The simultaneous firing of explosive bolts holding ball and socket, and spring-actuated separation mechanisms located fore and aft on each motor separate the solids from the vehicle.

The second stage is powered by the TRW TR-201 liquid bipropellant engine using N_2O_4 as the oxidizer and Aerozene-50 as the fuel. Pitch and yaw steering during powered flights is provided by gimballing the engine. Roll steering during powered flight and all steering during coast are provided by a GN_2 cold gas system.

The guidance and control system of the vehicle is located on top of the second stage. The strap-down Delta Inertial Guidance System (DIGS) provides guidance and control for the total vehicle from lift-off through attitude orientation. The system is composed of a digital computer provided by Delco and either the Inertial Measurement Unit (IMU) provided by Hamilton Standard or the Delta Redundant Inertial Measurement System (DRIMS) developed by McDonnell Douglas Astronautics Co.

First and second stage telemetry systems are similar, both combining the use of pulse duration modulation and frequency modulation. Critical vehicle functions are monitored to provide data for determining which components, if any, are not functioning properly during ascent.

A payload attach fitting is secured to the second-stage adapter and is used to support the satellite which is clamped to the attach fitting by a circumferential retaining strap, or clamp band assembly. A separation command from the guidance computer releases the clamp band by the firing of two explosive bolt cutters.

This same command simultaneously initiates the second-stage retrojets to provide a relative separation velocity of 0.5 me (1.6 ft.) per second. The retrojets use residual helium from the propellant-tank pressurization system. Three further burns are required after separation for evasive and depletion maneuvers.

The standard Delta 5724 attach fitting has been selected for IRAS. This attach fitting as currently designed and tested is capable of supporting an 1,134 kg (2,500 lb.) spacecraft.

The satellite protective fairing is 7.9 m (25.9 ft.) long and 2.4 m (8 ft.) in diameter. The fairing is aluminum and constructed in two half-shells. The fairing half-shells are jettisoned by activation of the base separation nuts and the contamination-free mild detonating fuse in the thrusting joint cylinder cavity.

The following tables show the flight sequence of events, the mission requirements, the flight mode description, and the predicted orbit dispersion.

FLIGHT SEQUENCE OF EVENTS
(IRAS MISSION)

EVENT	TIME (SEC)
Liftoff	0
Six Solid Motors Burnout	57.8
Three Solid Motors Ignition	60.0
Jettison Six Solid Motor Casings	78.0
Three Solid Motors Burnout	118.0
Jettison Three Solid Motor Casings	120.0
Main Engine Cutoff (MECO)	226.7
Stage I-II Separation	234.7
Stage II Ignition	239.7
Jettison Fairing	244.0
Second Stage Engine Cutoff (SECO-1)	537.5
Restart Stage II	3500.1
Spacecraft Separation	3740.0
Start Maneuver to Pix-II Attitude	4075.0
Finish Maneuver to Pix-II Attitude	6140.0

MISSION REQUIREMENTS

NOMINAL ORBIT PARAMETERS AT SPACECRAFT INJECTION

Orbit Altitude (circular)	920 km
Inclination (sun synchronous)	99.1 degrees
SPACECRAFT WEIGHT (AT LIFTOFF)	1077 kg

IRAS FLIGHT MODE DESCRIPTION

* LAUNCH FROM SLC-2W AT WSMC (Vandenberg AFB, Calif.)
* LAUNCH WINDOW IS JAN. 25 1983 FROM 6:17 PM TO 6:33 PM PST
* FLIGHT AZIMUTH: 196 DEGREES
* 6/3 CASTOR IV BURN SEQUENCE
* BOOSTER DOG-LEG MANEUVER TO ACHIEVE DESIRED ORBIT INCLINATION
* SECOND STAGE FIRST BURN RESULTS IN 247 N.MI. X 494 N.MI. X 99.1 DEG ORBIT
* VEHICLE MANEUVERS TO SPACECRAFT COAST ATTITUDE
* VEHICLE COASTS TO NEAR APOGEE OF TRANSFER ORBIT
* VEHICLE MANEUVERS TO SECOND STAGE RESTART ATTITUDE
* SECOND STAGE RESTART BURN OF APPROXIMATELY 7 SECONDS PLACES VEHICLE IN FINAL ORBIT
* VEHICLE MANEUVERS TO SPACECRAFT SEPARATION ATTITUDE
* VEHICLE MANEUVERS TO PIX-II (PIGGYBACK EXPERIMENT) ATTITUDE FOLLOWING IRAS SEPARATION (PIX DOES NOT SEPARATE)

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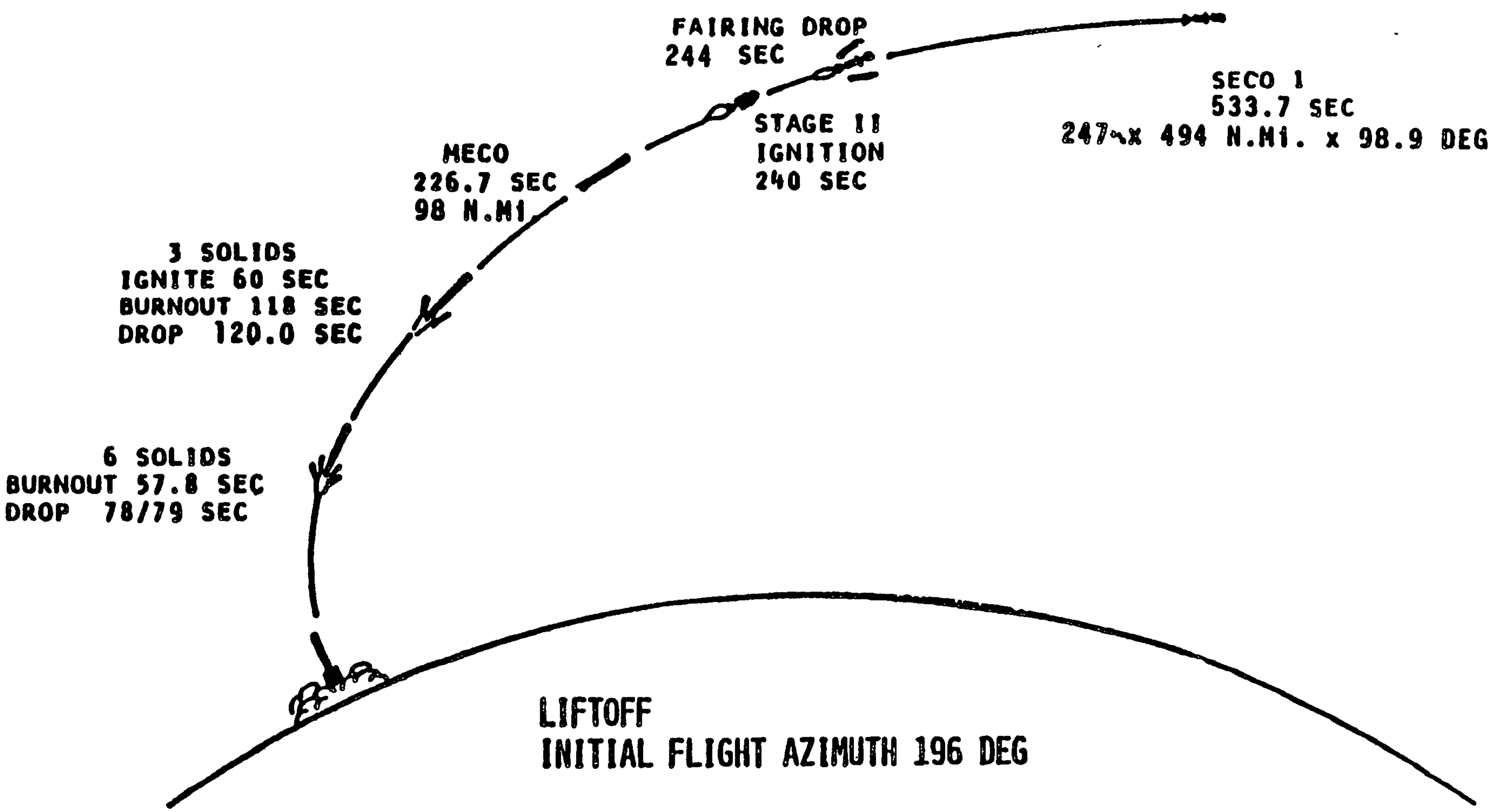
IRAS BOOST PROFILE



LAUNCH OPERATIONS

NASA's John F. Kennedy Space Center is responsible for the preparations and launch of Delta 166 which will carry the Infrared Astronomical Satellite (IRAS) into orbit.

On Sept. 8, the Delta first stage and interstage were erected on Space Launch Complex 2-West at Vandenberg Air Force Base. The first and second stages were mated on Sept. 23, and the nine solid strap-on motors were mounted in place around the base of the first stage on Dec. 15. The first major test of the electrical and mechanical systems of the rocket has been conducted, and final simulated test flight is scheduled for Jan. 7.

The IRAS spacecraft arrived at Vandenberg Air Force Base on Nov. 2. The major electronics test of the spacecraft has been completed at the NASA Spacecraft Laboratory, Building 836. The joint industry-government test team was to install the solar array panels and perform other mechanical checks on the spacecraft on Jan. 4. On Jan. 10 and 11, the IRAS satellite and the Plasma Interaction Experiment (PIX), its secondary payload, were to be mated with the Delta vehicle. The final helium top-off of the infrared telescope dewar was scheduled several days prior to launch. A dress rehearsal for the spacecraft is scheduled for Jan. 17. The spacecraft will go through a final countdown simulation to verify its readiness, along with that of the world-wide tracking network. On Jan. 20 the mated spacecraft and Delta vehicle will undergo a flight verification test, which will check the readiness of the stacked vehicle and its payloads. This will be the last major test conducted before the scheduled Jan. 25 launch.

TRACKING AND COMMUNICATIONS

Support for launch and early orbit operations, including pre-launch testing, will be provided by the Goddard Spaceflight Tracking and Data Network (STDN).

Voice and data communications lines, including a (56 kb/s) wideband data link will be provided by the Goddard NASA Communications Network (NASCOM).

IRAS SCIENCE TEAM

UNITED STATES

Dr. Hartmut Aumann	Jet Propulsion Laboratory
Dr. Nancy Boggess	NASA Headquarters
Dr. Fred Gillett	Kitt Peak National Observatory
Dr. Michael Hauser	Goddard Space Flight Center
Dr. James Houck	Cornell University
Dr. Frank Low	University of Arizona
Dr. Gerry Neugebauer	California Institute of Technology Co-chairman, JISWG
Dr. B. Tom Soifer	California Institute of Techology
Dr. Russell Walker	Jamieson Engineering

THE NETHERLANDS

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Dr. Jan Borgman	Radio Astronomy Observatory at Dwingeloo
Dr. Teije de Jong	University of Amsterdam
Dr. Harm Habing	Huygens Laboratory, Leiden Co-chairman, JISWG
Dr. Stewart Pottasch	Astronomical Observatory Kapteyn at Roden
Dr. Paul Wesselius	University of Groningen

UNITED KINGDOM

Dr. Peter Clegg	Queen Mary College
Prof. Richard Jennings	University College London
Prof. Phillip Marsden	University of Leeds

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Dr. Nancy Boggess	Program Scientist

Jet Propulsion Laboratory

W. Eugene Giberson	Co-chairman, JIPEG
Gerald M. Smith	Project Manager
Gael F. Squibb	Deputy Project Manager
Dr. Conway W. Snyder	Deputy Project Manager for Science

Kennedy Space Center

Richard G. Smith	Director
Thomas S. Walton	Director, Cargo Operations
Charles D. Gay	Director, Expendable Vehicles Operations Directorate
Wayne McCall	Chief, Delta Operations Division
Ray Kimlinger	Chief, Delta Western Operation Branch
W. P. Murphy	Manager, STS Resident Office (VAFB)
Gene Langenfeld	Spacecraft Coordinator

THE NETHERLANDS

Netherlands Agency for Aerospace (NIVR)

Ir. Peter Linssen	Co-chairman, JIPEG

Industrial Consortium IRAS (ICIRAS)

Ir. Jan de Koomen, Fokker	Project Manager
Ir. Richard Fok	Chief Engineer

Hollandse Signaalapparaten

Ir. Ad Vialle, Fokker	Satellite Integration and Test Manager
Ir. Ad Pouw, Fokker	Mission Analysis Manager
Ir. Richard van Holtz, NLR	Mission Operations Manager

UNITED KINGDOM

Science and Engineering Research Council (SERC)

Dr. Eric Dunford	Project Manager
Allan Rogers	Deputy Mission Operations Manager
Dr. Graham Thomas	Preliminary Analysis Facility Manager
Dr. Richard Holdaway	IRAS Ground Operations Manager

MAJOR CONTRACTORS AND SUBCONTRACTORS

UNITED STATES

Ball Aerospace Systems Div. Boulder, Colo.	Telescope
Perkin-Elmer Corp. Norwalk, Conn.	Optics
Odetics Inc. Anaheim, Calif.	Tape recorder
Motorola Government Electronics Div. Scottsdale, Ariz.	NASA Standard S-band Transponder
McDonnell Douglas Astronautics Co. Huntington Beach, Calif.	Launch vehicle

THE NETHERLANDS

Fokker Schipol	Spacecraft: Structure, thermal control, solar panels, mechanical integration and test; mission analysis
Hollandse Signaalapparaten Hengelo	Onboard computer, power subsystem, communications, spacecraft electrical integration and test.
National Aerospace Laboratory (NLR) Emmeloord	Coordination of ground operations, checkout equipment, test support, onboard software
Joint effort by Fokker, Hollandse Signaalapparaten and NLR	Satellite integration and test, satellite launch preparation
Space Research Laboratory University of Groningen	Dutch Additional Experiment

UNITED KINGDOM

Rutherford Appleton Laboratory	Ground station, Mission Control Center, Preliminary data analysis

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