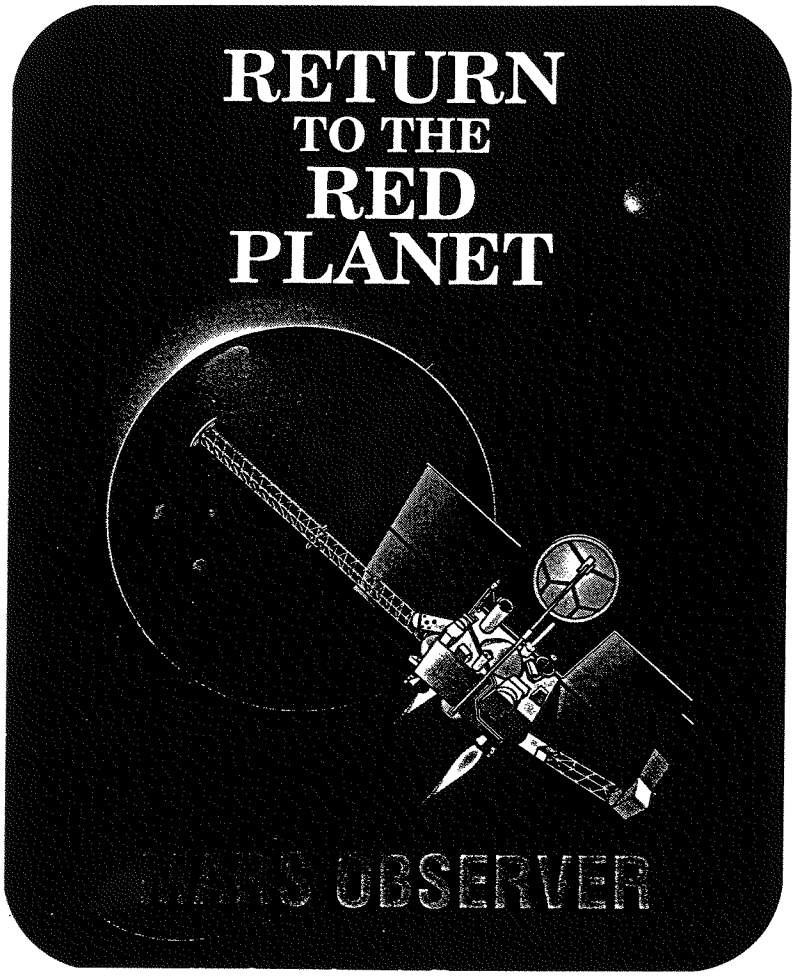
MARS OBSERVER

Mars Orbit Insertion

August 24, 1993



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GENERAL RELEASE

The National Aeronautics and Space Administration's Mars Observer spacecraft arrives at Mars at approximately 1:40 p.m. Pacific Daylight Time on Aug. 24, 1993, after an 11-month, 450-million-mile (720-million-kilometer) journey through the inner solar system.

The Mars Observer mission is a global scientific mapping mission. The spacecraft carries a complement of new instruments to the Red Planet, and it will provide a long-lived orbital platform from which these instruments will examine the entire Martian surface, atmosphere and interior. Measurements will be collected from a low-altitude, nearly polar orbit, 234 miles (378 kilometers) above the Martian surface, over the course of one complete Martian year -- the equivalent of about two Earth years or 687 Earth days.

"Throughout its primary, two-year mission, Mars Observer will gather information on the geology, geophysics and climate of Mars," said JPL Project Manager Glenn E. Cunningham.

"The mission will provide a global portrait of Mars as it exists today," he said. "This view will help planetary scientists to better understand the history of Mars' evolution, and will provide clues about the planet's interior and surface evolution. With this information, we will have a better understanding of the history of all of the inner planets of the solar system, including our own Earth."

Mars Observer continues NASA's long exploration of the Red Planet, which began nearly 30 years ago with the Mariner IV spacecraft that produced the first pictures of the planet's

cratered surface. The last U.S. spacecraft to visit Mars were the twin Viking orbiters and landers, which arrived at Mars in 1976. The landers touched down on the Martian surface and analyzed samples of the Martian surface to look for signs of life in the planet's distant past.

Mars Observer was lofted into Earth orbit at 1:05 p.m. Eastern Daylight Time (10:05 a.m. Pacific Daylight Time) on Sept. 25, 1992, aboard a Titan III launch vehicle with a Transfer Orbit Stage (TOS) booster, which later injected the spacecraft on its path to Mars.

Once on course for the cruise to Mars, the spacecraft deployed four of its six solar panels to begin generating solar power, and partially extended its high-gain antenna and two booms on which science instruments are mounted. The low-gain antenna was used for initial spacecraft communications, until the spacecraft was far enough away from Earth in early January 1993 to require use of the dish-shaped, high-gain antenna.

Mars Observer's seven science instruments were calibrated during the cruise to Mars. In addition, the radio science team participated in a three-week attempt to detect gravity waves using the spacecraft's own telecommunication system with those of two other interplanetary spacecraft, Galileo and Ulysses. All spacecraft subsystems and the instrument payload have performed well as Mars Observer headed for its destination, said Dr. Sam Dallas, Mars Observer mission manager at JPL.

"Since launch, we have sent more than 500 command files to the spacecraft, containing instructions to be carried out by the

spacecraft and its payload," Dallas said. "The spacecraft has executed these instructions flawlessly, except on two or three occasions when minor errors occurred. The spacecraft and payload hardware have had no failures thus far."

When the spacecraft reaches Mars on Aug. 24, onboard rocket engines will fire to slow the spacecraft's speed by more than 1,500 miles per hour (2,400 kilometers per hour) with respect to Mars and allow the craft to be captured by Mars' gravity. Mars Observer will then follow a "power in" orbit insertion strategy, using seven braking and orbit trim maneuvers to insert the spacecraft into the planned mapping orbit in less than three months (see Orbit Insertion Maneuver schedule, page 10).

The first insertion maneuver, called Mars Orbit Insertion (MOI), is the largest and most critical maneuver to be performed by the spacecraft. When the spacecraft is about 1,072 miles (1,730 kilometers) above the surface of the planet, it will fire two of its four large, 490-Newton thruster rockets to slow its speed enough to enter orbit around Mars, said Suzanne Dodd, Mars Observer mission planning team chief. The burn will last 29 minutes and place the spacecraft at about 308 miles (498 kilometers) above the Martian surface at periapsis, the closest approach to the planet.

"Mars Observer will be flying over the north pole and Olympus Mons, a huge Martian volcano, when it enters orbit around Mars," Dodd said. "The spacecraft will first spend 10½ days in this highly elliptical orbit around the planet, completing just one orbit around Mars every three days."

Instrument calibrations and some science measurements will take place during the elliptical orbit phase, according to Dr. Arden Albee, Mars Observer project scientist.

"The spacecraft will be crossing in and out of the planet's magnetic field during this initial, three-day orbit around Mars," Albee said. "Mars Observer will be able to make unique measurements of the interactions of magnetic field lines with the solar wind that will not be observable from the lower altitude mapping orbit.

"This will also be a critical period for Magnetometer and Gamma Ray Spectrometer calibrations," he said. "Noise from the spacecraft will have to be subtracted out to obtain the magnetic and gamma ray signatures of Mars, and that can only be done as the spacecraft moves closer and then farther away from this planetary boundary."

Eleven days after MOI, the first of two trim maneuvers, called Elliptical Change Maneuvers (ECM-1 and ECM-2), will be performed to slow the spacecraft into a one-day "drift orbit" around Mars. The spacecraft will spend 32 days in this 23-hour orbit, waiting for Mars to move around the sun so that it can drift into the correct lighting position for the mapping orbit (2 p.m. local Mars time) without using up valuable fuel reserves. A third ECM will adjust the orbit parameters before the spacecraft begins to descend into the low-altitude mapping orbit.

The entire spacecraft payload will be turned on and calibrated during this one-day drift orbit. From Sept. 16 to Oct. 16, all instruments except the Mars Observer Laser Altimeter (MOLA) will be operating for varying amounts of time. From this

orbit, Mars Observer may also be able to make observations of Phobos, the larger of Mars' two moons. The science payload may help determine the surface mineral content of this potential asteroid as the spacecraft passes possibly as close as 248 miles (400 kilometers) from Phobos during each orbit of Mars.

An instrument called the Pressure Modulator Infrared Radiometer (PMIRR) will make radiometric scans of Phobos in visible and infrared wavelengths, while the Thermal Emission Spectrometer (TES) measures the temperature of this airless body. The Magnetometer and Electron Reflectometer will measure particle disturbances in the Martian atmosphere caused by Phobos' orbit around Mars. Imaging by the Mars Observer Camera (MOC) may be attempted, depending on how closely the spacecraft passes by the moon.

As the spacecraft continues to circularize its orbit, NASA's Deep Space Network 112-foot (34-meter) antennas will be used to begin a radio science experiment, measuring small shifts in the spacecraft's velocity that will tell scientists more about the planet's gravity field.

Two Transfer-to-Low-Orbit (TLO) maneuvers will then bring the spacecraft into the near-circular mapping orbit. The first, TLO-1, will be performed on Oct. 17 to bring the spacecraft into a 4.2-hour orbit. After that maneuver has been performed, the spacecraft will spend a week characterizing the complete gravity field of Mars in detail. A gravity map of the entire planet will be created from variations in the radio signals from the spacecraft due to variations in mass distribution around the planet.

TLO-2 will be performed on Oct. 28 to adjust the orbit again and bring the spacecraft into the desired 118-minute mapping orbit. A subsequent trim maneuver (Orbit Change Maneuver or OCM) will occur on Nov. 8 to correct any small errors in the orbit.

On that day, 76 days after Mars orbit insertion, the spacecraft will reach its near-circular, near-polar mapping orbit, inclined 93 degrees to the planet's equator.

Starting on Nov. 12, the spacecraft will fully deploy the two remaining solar panels, the high-gain antenna and the two science booms in preparation for the start of mapping. Boom deployments will occur a month ahead of solar conjunction -- the period when the spacecraft moves behind the sun as seen from Earth -- to insure that any problems associated with all these deployments can be solved before spacecraft-to-Earth communications are diminished.

All of the spacecraft's instruments will be turned on Nov. 23 for a final in-orbit checkout. Mars Observer will undergo in-orbit checkout through Dec. 16, operating its payload and testing its mapping command sequences. Data from this final checkout phase will allow the spacecraft to obtain one complete global map of the surface -- a process which takes 26 days -- before the solar conjunction in December blocks spacecraft communications.

"There is a very distinct advantage to getting this first mapping cycle right up front," Albee said. "The Martian dust storms occur roughly between February and August, so the atmosphere should be very clear in November when we begin mapping. An early start will also provide us with an excellent opportunity to obtain data before and after a Martian dust storm,

since the dust storm period will resume in February 1994."

In addition to allowing Mars Observer to observe the birth and development of a global Martian dust storm -- if one should occur this Martian year -- the first 26-day mapping period will allow the scientific teams to become more familiar with operating their instruments from more than 200 million miles away.

In its mapping orbit, the spacecraft will circle the planet at a speed of about 7,500 miles per hour (12,000 kilometers per hour) with respect to Mars and in an orbit that will take it close to both poles. On the day side of the planet, Mars Observer will be traveling from north to south. On each orbit, it will cross the equator at about 2 p.m. local Mars time. It will always see the surface of Mars on the daylit side as it appears at mid-afternoon. This "sun-synchronous" orbit puts the sun at a standard angle above the horizon in each image, with the mid-afternoon lighting angle casting shadows that will make surface features stand out.

Solar conjunction begins on Dec. 20 and lasts through Jan. 3, 1994. During this time, Mars' orbit around the sun will take the spacecraft behind the sun as seen from Earth. This planetary alignment will create a "command moratorium" for mission operations.

"Ground-controllers will be out of contact with the spacecraft and will not transmit radio signals because of the noise caused by the sun's interference," Dallas said. "The spacecraft, however, will be fully deployed and in the mapping configuration, thereby minimizing the risk of problems occurring during this break in communications."

Experiment teams, who will control the spaceborne instruments from their home institutions, will also be out of contact with the spacecraft. But as two-way communication is restored in early January 1994, they will begin to command their experiments and access data daily using a computer network linking them to the Mars Observer operations center at JPL.

The Mars Observer mission is expected to yield more than 600 billion bits of scientific data, many times the amount of data returned by all previous missions, both American and Russian, to Mars.

Mars Observer will examine the entire planet, from the ionosphere, an envelope of charged particles surrounding Mars, down through the atmosphere to the surface and deep into the interior. Scientists will glean valuable new information on daily and seasonal weather patterns, geological features, and the migration of water vapor over a complete Martian year.

As the primary mission winds down in late 1995, the Mars Observer science team will participate in a collaborative effort of international cooperation. The Mars Observer spacecraft carries a radio system supplied by the French Centre National d'Etudes Spatiales (CNES) that will periodically receive and relay data from small instrument packages landed on the Martian surface by the Russian Mars '94 mission, which will arrive at Mars in September 1995.

The Russian landed experiment packages will directly measure the Martian atmosphere and surface properties. Data will be relayed to both a Russian Mars '94 orbiter and the Mars Observer spacecraft. Once received, the data will be stored and processed

for relay back to Earth. The Russian instrument packages are designed to operate for several years.

If Mars Observer is still operating as late as 1997, the spacecraft may support a second Russian mission, called the Mars '96 mission. The Mars '96 mission is being designed to release a balloon into the Martian atmosphere and possibly deploy landed stations or rovers that could explore the Martian surface either through remote control from Earth or under autonomous computer control. Following a launch in 1996, the Mars '96 spacecraft would reach Mars in 1997.

Glenn E. Cunningham of the Jet Propulsion Laboratory is the Mars Observer project manager. Dr. Arden Albee of the California Institute of Technology is the project scientist. Dr. Sam Dallas of the Jet Propulsion Laboratory is the mission manager. William C. Panter of NASA Headquarters is the program manager and Dr. Bevan M. French of NASA Headquarters is the program scientist.

The spacecraft was built under contract to NASA and JPL by the Martin Marietta Astro-Space Division (formerly General Electric) in Princeton, N.J. NASA's Deep Space Network is supporting mission operations and tracking of the spacecraft throughout the primary mission.

The Jet Propulsion Laboratory in Pasadena, Calif., manages the Mars Observer mission for the Solar System Exploration Division of NASA's Office of Space Science, Washington, D.C.

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MARS OBSERVER ORBIT INSERTION MANEUVERS

MOI 8/24/93	MOI is the first orbit insertion maneuver that brakes the spacecraft into the elliptical capture orbit. Once performed, the spacecraft will be in a three-day (75-hour) orbit around Mars. MOI occurs at 1:40 p.m. PDT on Aug. 24, 1993.
ECM-1 9/4/93	The first trim maneuver to the elliptical capture orbit is scheduled for 10.4 days after MOI. ECM-1 will put the spacecraft in a three-day "drift orbit" to distinguish it from the capture orbit.
ECM-2 9/15/93	The second trim maneuver is scheduled for 11.3 days after ECM-1 to lower the spacecraft into the one-day drift orbit. The spacecraft will be maintained in the drift orbit for the next 32 days, until the 2 p.m. solar orientation is nearly reached.
ECM-3 10/7/93	The third trim maneuver occurs 10 days before the TLO-1 maneuver. This is a small statistical maneuver to clean up errors in the drift orbit.
TLO-1 10/17/93	TLO-1 is the third braking maneuver, which lowers the spacecraft from the elliptical drift orbit to the 4.2-hour orbit. The 4.2-hour period of this intermediate orbit was selected to take out about half of the energy required to reach the mapping orbit.
TLO-2 10/28/93	TLO-2 is the fourth and last large braking maneuver to lower the spacecraft into the mapping orbit. It will occur 11 days after TLO-1. Because most of the bipropellant is being expended, this maneuver has the highest acceleration level of the mission.
OCM-1 11/8/93	The Orbit Change Maneuver is the final orbit maneuver to correct any errors in the mapping orbit. OCM-1 will be performed 11 days after TLO-2.
12/20/93- 1/3/94	Solar conjunction.

-END OF GENERAL RELEASE-

MARS OBSERVER SCIENCE OBJECTIVES

The Mars Observer mission will study the geology, geophysics, weather and climate of Mars. The mission's primary objectives are to identify and map the chemical and mineral composition of the surface; measure the topography of surface landforms; define the gravitational field; and search for a planetary magnetic field. The mission will also determine the distribution, abundance, sources and destinations of carbon dioxide, water and dust over a seasonal cycle, and will measure the atmospheric temperature and the water and dust content in the atmosphere.

Since all of these objectives involve global mapping, the mission will provide scientists with a global portrait of Mars as it exists today through a scientifically focused set of experiments. The spacecraft's instruments are similar to those now used to study the Earth. During its 687-day mapping mission, Mars Observer will return more than 600 billion bits of scientific data -- more than that returned by all previous missions to Mars.

MISSION DESIGN

The near-polar orbit that was chosen for the Mars Observer mission is low enough to allow close-range study of Mars, but high enough so that the atmosphere does not drag excessively on the spacecraft. The orbit is also sun-synchronous; the spacecraft will pass over Mars' equator at the same local time during each orbit -- about 2 p.m. on the day side and about 2 a.m. on the night side. This orbit is essential for a number of

measurements, as it helps distinguish daily atmospheric variations from longer term, seasonal variations.

During the mission's mapping cycle, data reception from the spacecraft and command updates to the spacecraft and individual science instruments will be conducted on a daily basis.

The seven instruments on Mars Observer will gather data until November 1995. Near the end of its prime mission in the fall of 1995, Mars Observer will be joined at Mars by the Russian "Mars '94" spacecraft. Mars Observer is equipped to relay data to Earth from several penetrators and experiment packages that the Russians plan to place on the Martian surface. The radio-receiver equipment to accomplish this effort of international cooperation was supplied by the Centre National d'Etudes Spatiales (CNES) in France.

Once the primary mission is completed, the Mars Observer mission may be extended further -- if the spacecraft and instruments are still in good condition and if there is enough fuel to control the spacecraft's altitude and orientation.

SPACECRAFT SCIENCE INSTRUMENTS

Mars Observer's battery of seven scientific instruments will make an intense and long-term examination of Mars from orbit. Collectively, the instruments cover much of the electromagnetic spectrum and form a complementary array. Each instrument produces sets of data that contribute to a wide variety of scientific investigations.

Gamma Ray Spectrometer (GRS)

The Gamma Ray Spectrometer will measure the chemical elements present on and near the surface of Mars with a surface

resolution of a few hundred kilometers. The data will be obtained by measuring the intensities of gamma rays that emerge from the Martian surface. These high-energy rays are created from the natural decay of radioactive elements in Martian surface materials and are also produced by the interaction of cosmic rays with the atmosphere and surface.

By observing the number and energy of these gamma rays, it is possible to determine the chemical composition of the surface, element by element.

Mars Observer Camera (MOC)

The Mars Observer Camera system will photograph the Martian surface with the highest resolution ever accomplished by an orbiting civilian spacecraft. (Resolution is a measure of the smallest object that can be seen in an image.)

Low-resolution global images of Mars will also be acquired each day using two wide-angle cameras operated at 7.5-kilometer (4.7-mile) resolution per picture element. These same cameras will acquire moderate-resolution photographs at 240 meters (787 feet) per pixel.

A separate camera will acquire very-high-resolution images at 1.4 meters (4.6 feet) per pixel for features of special interest. Each of these camera systems uses a line array of several thousand detectors, and the motion of the spacecraft, to create the images.

The low-resolution camera system will capture global views of the Martian atmosphere and surface so that scientists may study the Martian weather and related surface changes on a daily basis. Moderate-resolution images will monitor changes in the

surface and atmosphere over hours, days, weeks, months and years. The high-resolution camera system will be used selectively, because of the high data volume required for each image.

Thermal Emission Spectrometer (TES)

The Thermal Emission Spectrometer will measure infrared thermal radiation emitted from the Martian atmosphere and surface. From these measurements the thermal properties of Martian surface materials and their mineral content may be determined. When viewing the surface beneath the spacecraft, the spectrometer has six fields of view, each covering an area of 3 by 3 kilometers (1.9 by 1.9 miles).

The spectrometer (a Michelson interferometer) will determine the composition of surface rocks and ice and map their distribution on the Martian surface. Other capabilities of the instrument will investigate the advance and retreat of the polar ice caps, as well as the amount of radiation absorbed, reflected and emitted by these caps. The distribution of atmospheric dust and clouds will also be examined over the four seasons of the Martian year.

Pressure Modulator Infrared Radiometer (PMIRR)

This radiometer will measure the vertical profile of the tenuous Martian atmosphere by detecting infrared radiation from the atmosphere itself. For the most part, the instrument will measure infrared radiation from the limb, or above the horizon, to provide high-resolution (5-kilometer or 3-mile) vertical profiles through the atmosphere.

The measurements will be used to derive atmospheric pressure and determine temperature, water vapor and dust profiles from

near the surface to as high as 80 kilometers (50 miles) above the surface. Using these measurements, global models of the Martian atmosphere, including seasonal changes that affect the polar caps, can be constructed and verified.

Mars Observer Laser Altimeter (MOLA)

The Mars Observer Laser Altimeter uses a very short pulse of light emitted by a laser to measure the distance from the spacecraft to the surface with a precision of several meters. These measurements of the topography of Mars will provide a better understanding of the relationship among the Martian gravity field, the surface topography and the forces responsible for shaping the large-scale features of the planet's crust.

Radio Science

The Radio Science investigation will use the spacecraft's telecommunication system and the giant parabolic (dish-shaped) antennas of NASA's Deep Space Network to probe the Martian gravity field and atmosphere. These measurements will help scientists determine the structure, pressure and temperature of the Martian atmosphere.

Each time the spacecraft passes behind the planet or reappears on the opposite side, its radio beam will pass through the Martian atmosphere briefly on its way to Earth. The way in which the radio waves are bent and slowed will provide data about the atmospheric structure at a much higher vertical resolution than any other Mars Observer experiment.

During that part of the orbit when the spacecraft is in view of Earth, precise measurements of the frequency of the signal received at the ground tracking stations will be made to

determine the velocity change (using the Doppler effect) of the spacecraft in its orbit around Mars. These Doppler measurements, along with measurements of the distance from the Earth to the spacecraft, will be used to navigate the spacecraft and to study the planet's gravitational field.

Gravitational field models of Mars will be used along with topographic measurements to study the Martian crust and upper mantle. By the end of the mission, as a result of the low altitude of the orbit and the uniform coverage of Mars Observer, scientists will have obtained unprecedented global knowledge of the Martian gravitational field.

Magnetometer and Electron Reflectometer (MAG/ER)

Mars is now the only planet in the solar system, aside from Pluto, for which a planetary magnetic field has not yet been detected. In addition to searching for a Martian planetary magnetic field, this instrument will also scan the surface material for remnants of a magnetic field that may have existed in the distant past. The magnetic field generated by the interaction of the solar wind with the upper atmosphere of Mars will also be studied.

Mars Relay Experiment

The spacecraft also carries a radio system supplied by the French Centre National d'Etudes Spatiales (CNES) to support robotic missions being implemented by the Russians.

The present Russian plan is to launch two spacecraft, one in 1994 and the other in 1996. The first would deploy penetrators into the surface of Mars and land small experiment packages on the surface for direct sampling of both the atmosphere and the

surface. The associated Mars Observer relay equipment consists of a transmitter/receiver that will periodically receive and relay to Earth scientific and engineering data from these landed packages. In 1996 the Russians plan to launch instrument packages, a balloon and, perhaps, a surface rover that would relay information back to Mars Observer if the spacecraft is still operational in late 1997.

THE SPACECRAFT SYSTEM

The Mars Observer spacecraft uses, where possible, existing Earth-orbiting satellite component designs. The craft's main body is shaped like a box and is about 1.1 meters (3.25 feet) high, 2.2 meters (7.0 feet) wide, and 1.6 meters (5.0 feet) deep. Mars Observer was built by Martin Marietta (formerly General Electric) Astro-Space in Princeton, N.J.

With its fuel, the spacecraft and its science instruments weigh about 2,565 kilograms (5,655 pounds). The spacecraft has a three-year design lifetime and is equipped with one large solar array, consisting of six 183 × 219 × 9.1-centimeter (6 x 7.2 x 0.3-foot) solar panels.

At launch, the spacecraft's main communication antenna, instrument booms and solar array were folded close to the spacecraft. During the cruise phase these structures were partially extended. The two 6-meter (20-foot) instrument booms carry two of Mars Observer's seven scientific instruments: the Magnetometer and Electron Reflectometer and the Gamma Ray Spectrometer.

After the Mars Observer spacecraft reaches its mapping orbit at Mars, the solar array and instrument booms will be fully

unfolded. The main communication antenna -- a 1.5-meter (5-foot) diameter parabolic antenna -- will be raised on a 5.3-meter (17-foot) boom and rotated to have a clear view of Earth. The spacecraft will then power its instruments to begin conducting the mission experiments.

MAPPING CYCLE

In its near-circular mapping orbit, the Mars Observer spacecraft will rotate once per orbit in order to keep the instruments pointed at the planet. This will allow all the instruments to view the planet continuously and uniformly during the entire Martian year. The spacecraft, instruments and mission were designed so that sufficient resources, especially of power and data rate, are available to power all instruments as they collect data simultaneously and continuously on both the day and night sides of the planet. The camera system takes photos only on the day side and will acquire additional images every three days during real-time radio transmissions to the Deep Space Network.

The rotation and orientation of the spacecraft are controlled by horizon sensors, a star sensor, gyroscopes and reaction wheels, as is common on Earth-orbiting satellites. The horizon sensors, adapted from a terrestrial design, continuously locate the horizon, providing control signals to the spacecraft. The star sensor will be used for attitude control during the 11-month cruise and as a backup to the horizon sensors during the mapping orbit.

Once during each 118-minute orbit, the spacecraft will enter the shadow of Mars and rely on battery power for about 40

minutes. The battery is charged by the spacecraft's large solar panel, which generates more than a kilowatt of power when it is in the sunlight to operate spacecraft subsystems and instruments.

Control of the spacecraft and instruments is accomplished through the use of onboard microprocessors and solid-state memories. Scientific and engineering data are stored on tape recorders for daily playback to Earth. Additional data operations will allow information to be returned in real-time from selected instruments whenever Earth is in view.

The lifetime of the spacecraft will most likely be determined by the supply of attitude-control fuel and the condition of the batteries. The following table summarizes some of the important performance features of the Mars Observer spacecraft.

Spacecraft Statistics

GENERAL	
Design Life	3 years
Mapping Orbit	Mars polar, nearly circular
Altitude Above Mars	378 km (234 miles), nominal
Key Features	Seven science instruments (two mounted on 6-m booms) Bi- and monopropulsion systems Three-axis control system (highly stabilized) Semiautonomous operation (stores up to 2000 commands)
Reliability	Redundancy used to avoid single-point failures
Weight at launch	
Dry (with payload)	1,125 kg (2,480 lb)
Fuel	1,440 kg (3,175 lb)
Total Weight	2,565 kg (5,655 lb)
Size (launch configuration):	
Length	1.6 m (5.0 ft)
Width	2.2 m (7.0 ft)
Height	1.1 m (3.25 ft)
COMMUNICATIONS	
Command Rate	12.5 commands/s (max)
Uplink Data Rate	500 bits/s (max)
Downlink Data Rate	85.3 kilobits/s (max)
Antennas	1.5-m-diam. high-gain parabolic articulating (on 5.3-m boom) Three low-gain
Downlink RF Power	44 watts
Tape Recorders	1.38×10^9-bit capacity
PROPULSION	
Bipropellant System	Monomethyl hydrazine and nitrogen tetroxide
Monopropellant System	Hydrazine
Thrusters (20 total)	(4) 490 N (4) 22 N (8) 4.5 N (orbit trim) (4) 0.9 N (momentum unloading and steering)
Total Propellant Weight	1,346 kg (2,961 lb)
ATTITUDE AND ARTICULATION CONTROL	
Pointing Accuracy	Control: 10 mrad Knowledge: 3 mrad
Pointing Stability	1 mrad (for 0.5 s) 3 mrad (for 12 s)
ELECTRICAL POWER	
Solar Array	6 panels, each 3.7 x 7 meters
Array Output Power	1,130 watts
Batteries	42-amp-hr NiCd (2)
Electronics	Bus voltage regulation

Definitions:
mrad = milliradian (≈ 0.057°)
N = newton (≈ 0.225 lb force)

SCIENCE OPERATIONS

The Mars Observer mission operations at the Jet Propulsion Laboratory will be supported by NASA's Deep Space Network and the JPL Advanced Multimission Operations System. The 34-meter (111-foot), high-efficiency subnetwork, the newest of the Deep Space Network antenna subnets, will provide daily uplink and downlink communications with the spacecraft at X-band frequencies of 8.4 gigahertz. The 70-meter (230-foot) antenna network will also provide periodic very-long-baseline interferometry and real-time, high-rate telemetry and radio science support to the mission.

The instrument scientists will remain at their home institutions, from which they will access Mars Observer data via a project database at JPL. Using workstations and electronic communications links, scientists will also be connected to the mission planning activities at JPL. In the same way, data products returned to the JPL database from the home institution for each of the instruments will be sent electronically to other investigators at their home institutions. This will allow scientists to have ready access to science data without moving to JPL for the duration of the mission.

More than 80 workstations will be connected to the project database at JPL, a centralized repository for downlink science and engineering telemetry data, ancillary data including navigation data, and uplink command and sequence data. This database, with about 30 gigabytes of on-line storage, will be electronically available to the science instrument investigators via NASCOM data links. The database will allow investigators to analyze their instrument data at their home institutions.

During the mapping phase, the instrument investigations will return processed science data products to the database at JPL for access by the interdisciplinary scientists and the other investigation teams. The Mars Observer mission is expected to return more than 600 billion bits of scientific data to Earth -- more than that returned by all previous missions to Mars and, in fact, roughly equal to the total amount of data returned by all planetary missions since the beginning of planetary exploration.

SOME SALIENT FACTS
ABOUT MARS OBSERVER

Speed in Earth orbit (with respect to Earth)	7.73 km/s (17,300 mph)
Speed at TOS burnout (with respect to Earth)	11.5 km/s (25,700 mph)
Average speed during cruise (with respect to Sun)	25.0 km/s (56,000 mph)
Speed before Mars orbit insertion maneuver (with respect to Mars)	5.28 km/s (11,800 mph)
Speed after Mars orbit insertion maneuver (with respect to Mars)	4.56 km/s (10,200 mph)
Speed in mapping orbit (with respect to Mars)	3.35 km/s (7,500 mph)
Distance traveled between Earth and Mars	7.24×10^8 km (450 million miles)
Distance from Earth at Mars arrival	3.4×10^8 km (210 million miles)
Distance from Earth during mapping phase	Min: 10^8 km (62 Mmi) Max: 3.7×10^8 km (230 Mmi)
Time for command to reach spacecraft during mapping phase	Min: 5.5 minutes Max: 20.5 minutes
Maximum acceleration on spacecraft (postlaunch) (occurs during transfer to low orbit)	0.1 G
Navigation target diameter at Mars (less than 1/10 of planet diameter)	480 km (300 miles)

MARS OBSERVER INVESTIGATORS

Gamma Ray Spectrometer (GRS)

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William K. Hartmann, Planetary Science Institute, Tucson, Ariz.
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Thermal Emission Spectrometer (TES)

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Pressure Modulator Infrared Radiometer (PMIRR)

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Mars Observer Laser Altimeter (MOLA)

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Magnetometer and Electron Reflectometer (MAG/ER)

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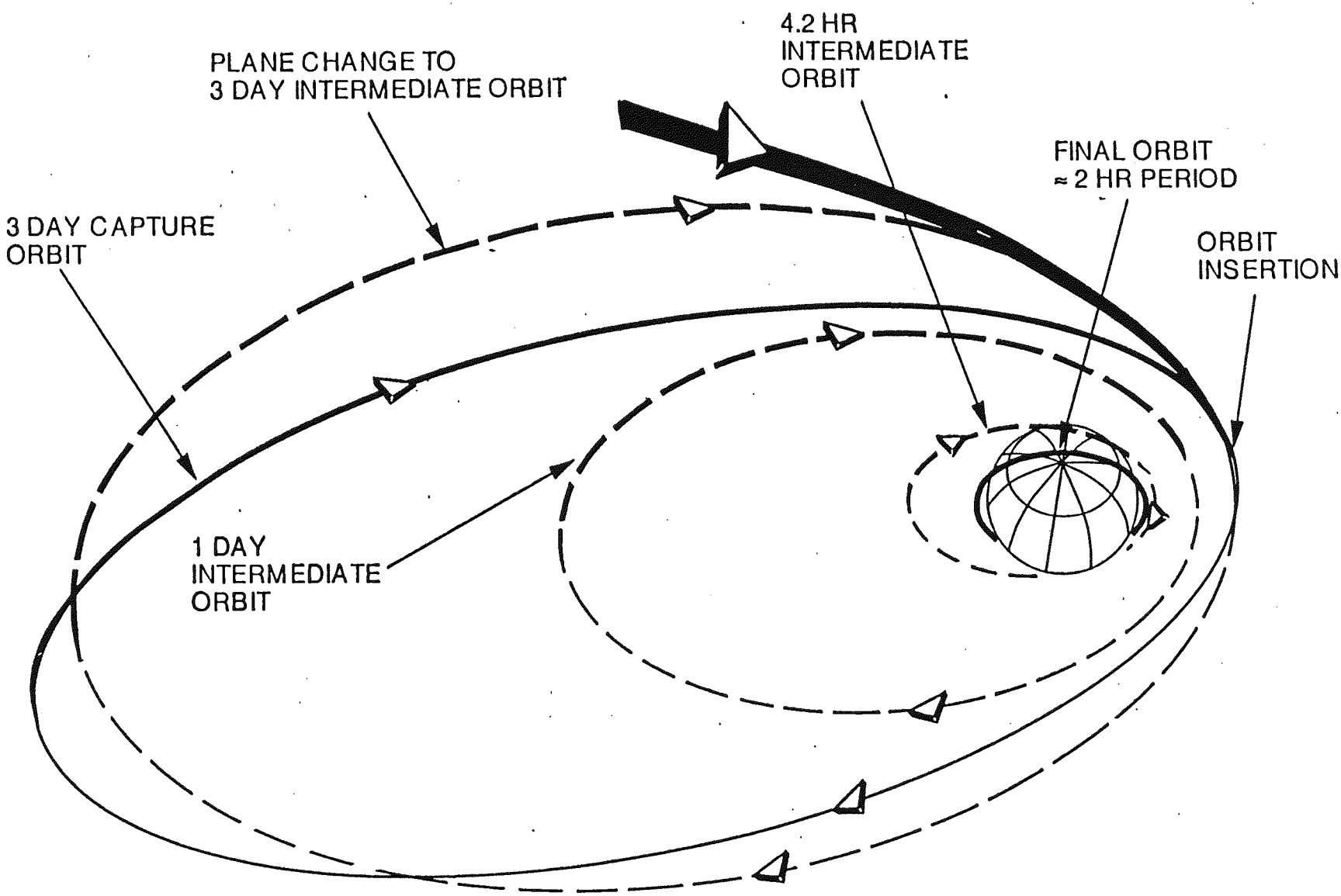
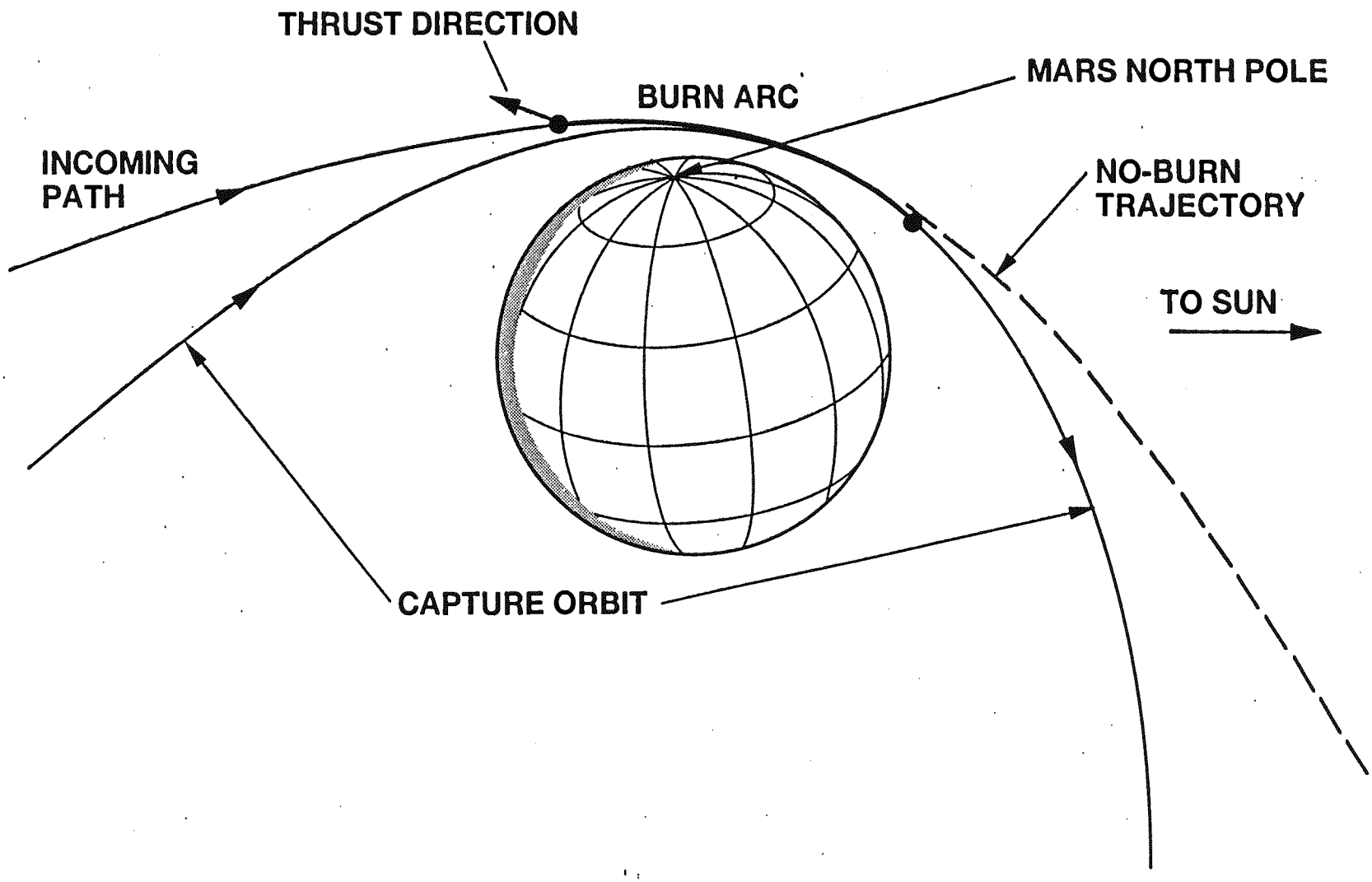
8/16/93 DEA



MARS OBSERVER ORBIT INSERTION AND CIRCULARIZATION
AUGUST 24 TO NOVEMBER 22 1993

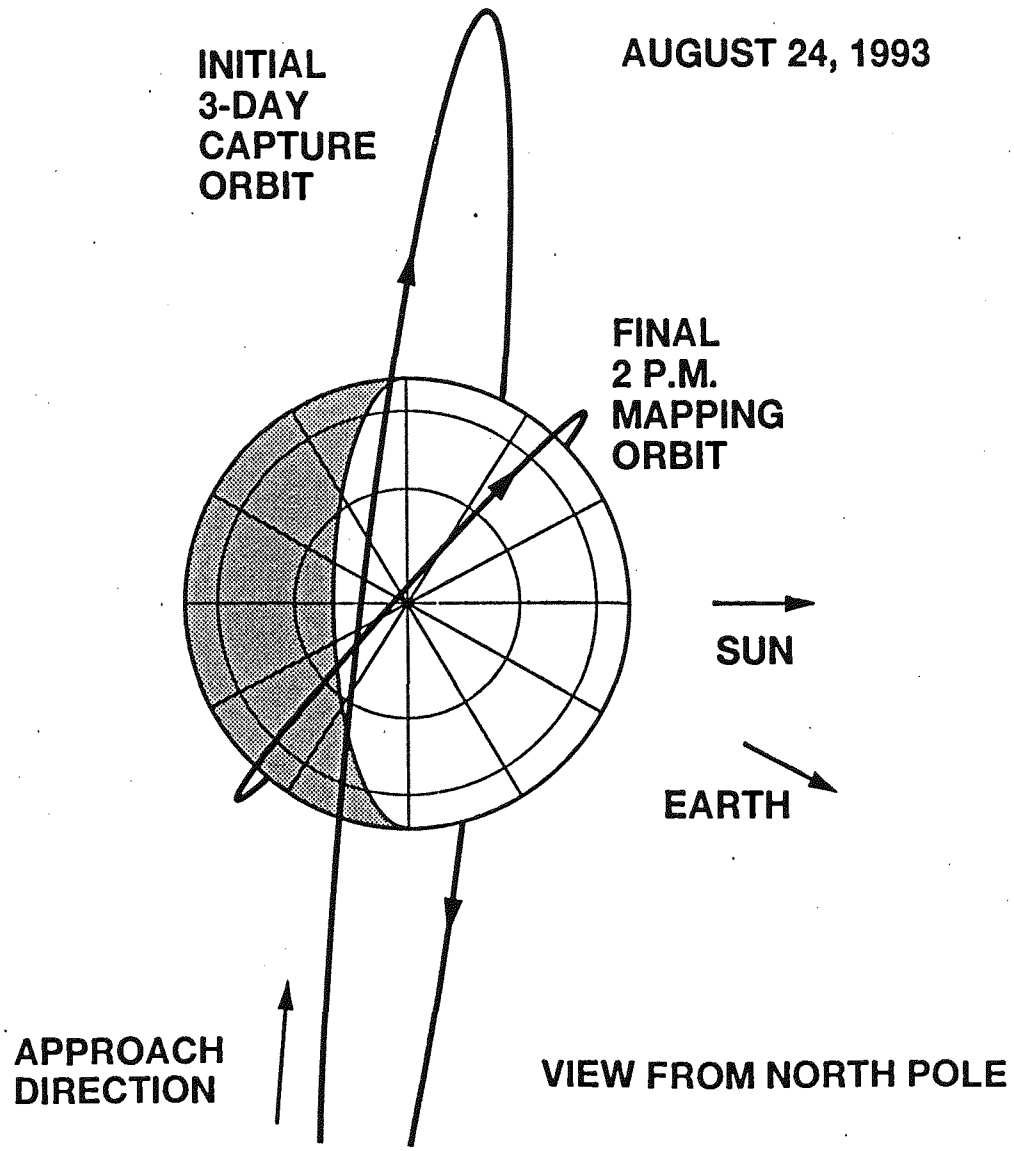
MARS OBSERVER

MARS ORBIT–INSERTION BURN AS VIEWED FROM EARTH



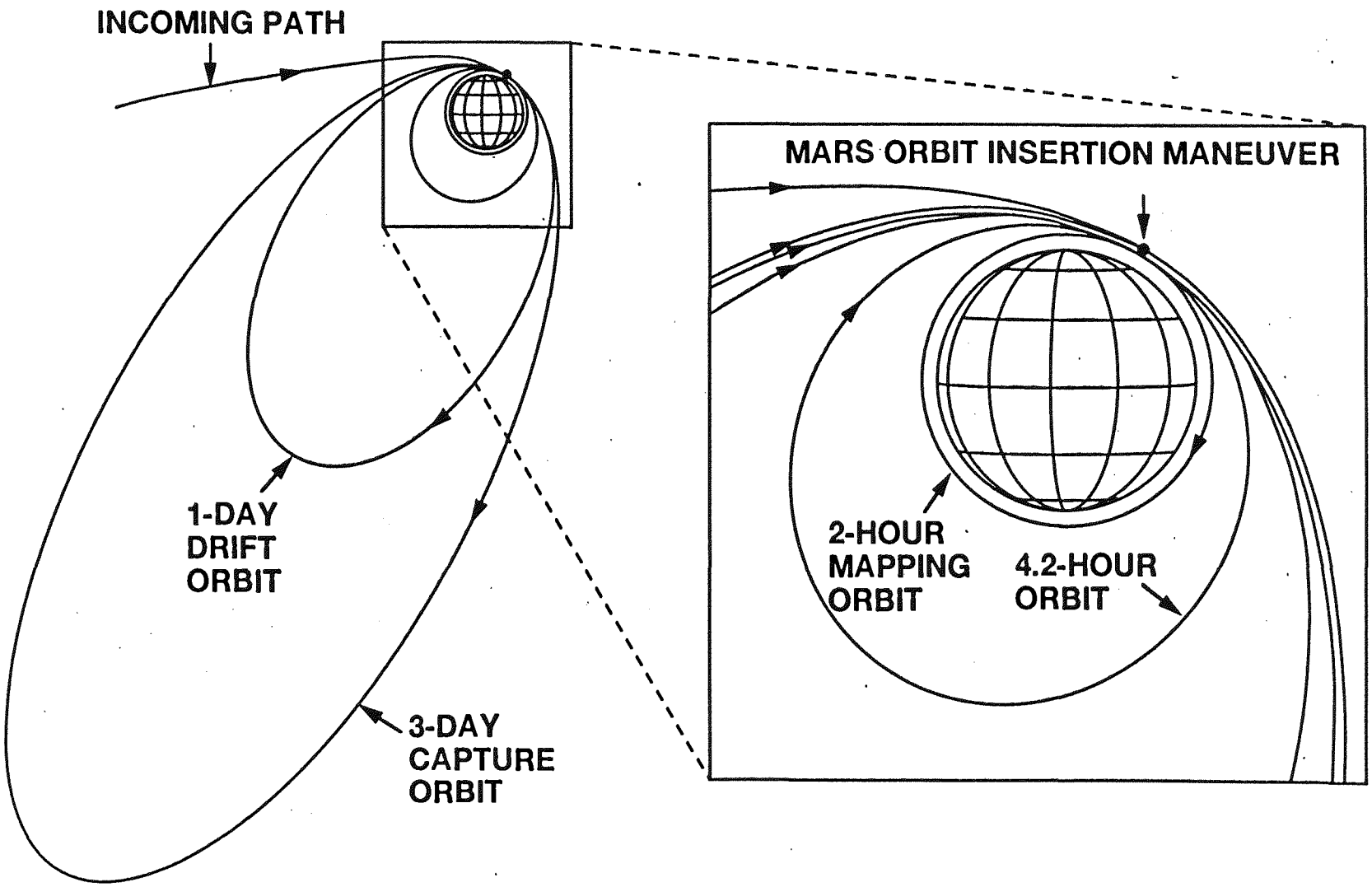
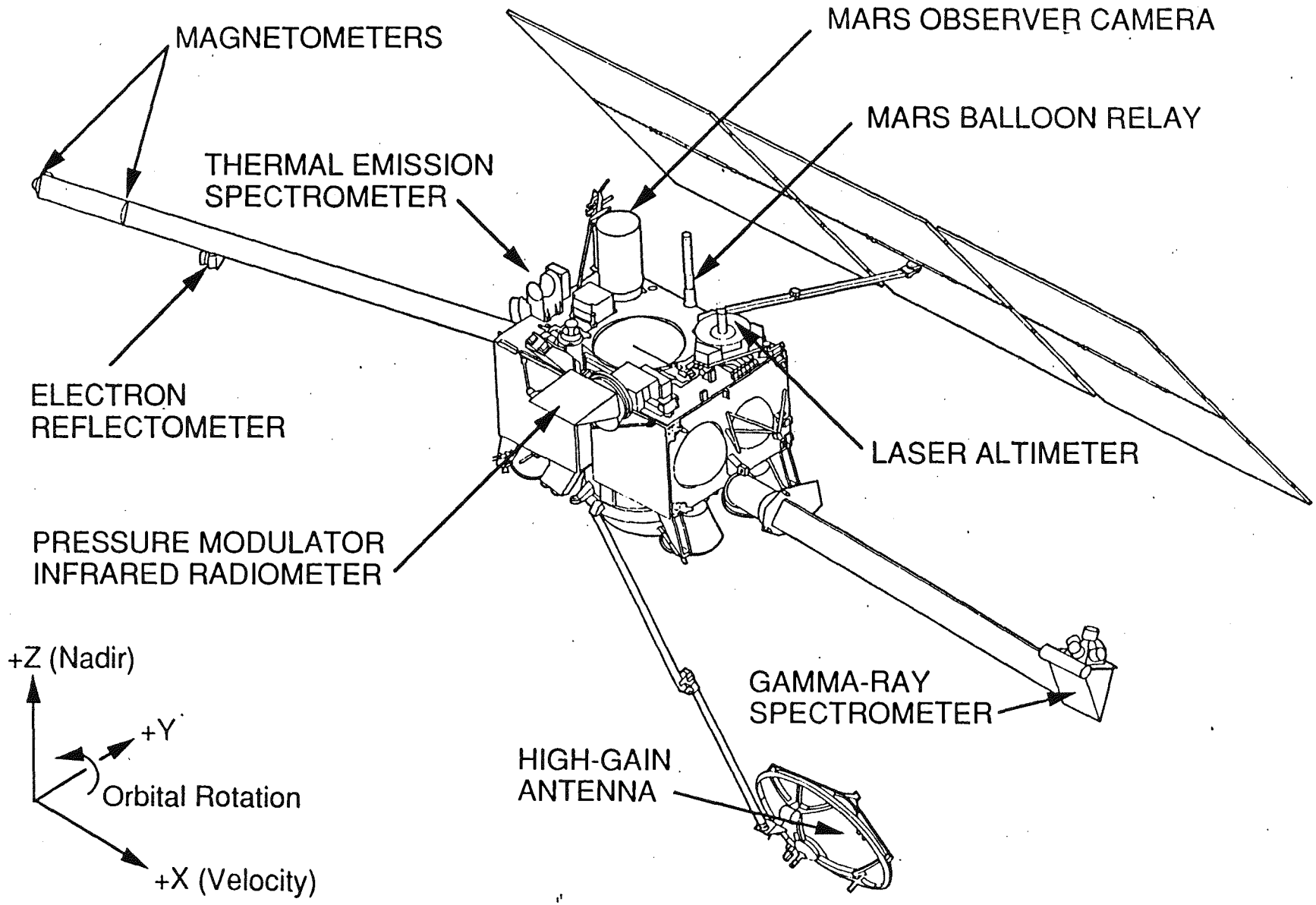
MARS OBSERVER

ORBIT INSERTION GEOMETRY



MARS OBSERVER

TRANSITION ORBITS



SPACECRAFT CONFIGURATION