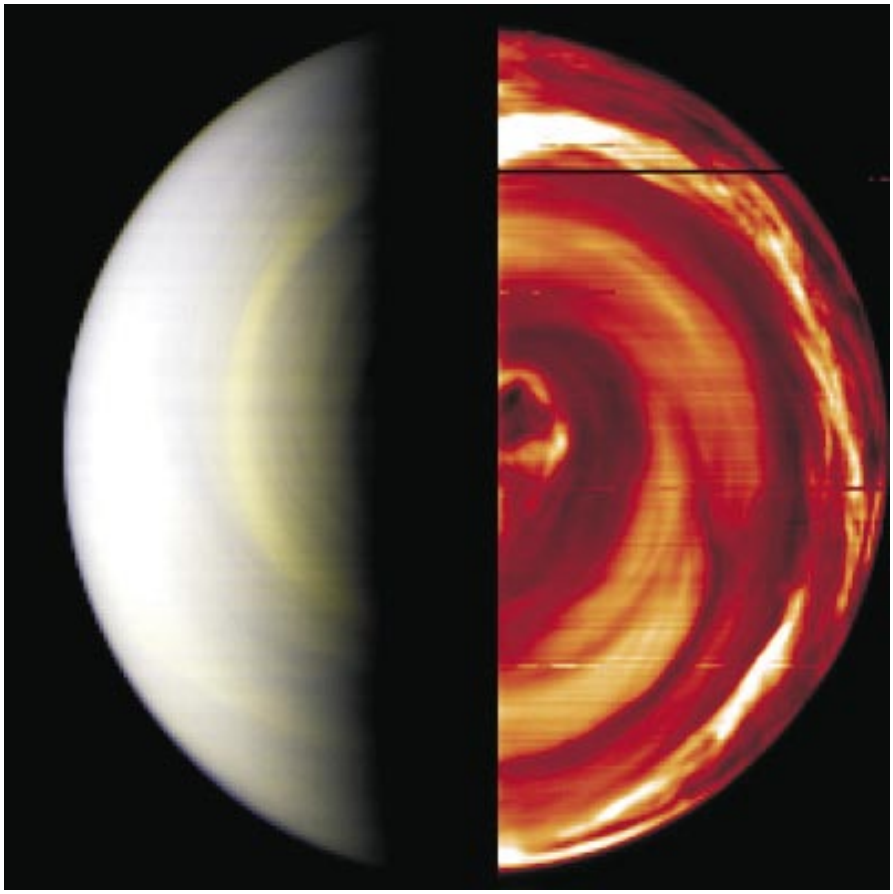
Europe Scores New Planetary Success

Venus Express Enters Orbit around the Hothouse Planet



FOCUS -Venus

The first picture of Venus taken from Venus Express .

Composite, false-colour view of Venus south pole captured by VIRTIS 12 April 2006 onboard Venus Express.

Photo Credits: ESA/INAF-IASF, Rome, Italy, and Observatoire de Paris, France

During the next four weeks, the Venus Express probe will perform a series of manoeuvres to reach the scheduled operational orbit for its scientific mission. It will move from its current highly elongated 9-day orbit to a 24-hour polar orbit, culminating at 66,000 km. From this vantage point, the orbiter will conduct an in-depth observation of the structure, chemistry and dynamics of the atmosphere of Venus for at least two Venusian days (486 Earth days).

Venus Express

When our ”inner neighbour” Venus these days is orbited by a European satellite, it is as a follow up of the Mars Express that orbits our “outward neighbour” for the third year in a row.

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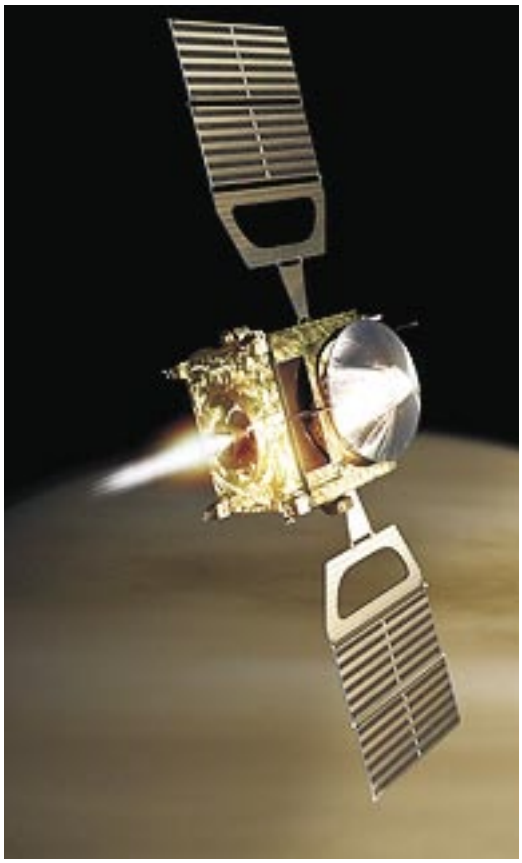


In the morning of April 11, at the end of a 153-day and 400-million km cruise into the inner solar system ESA's Venus Express space probe fired its main engine at which brought it into orbit around Venus. This orbit insertion manoeuvre was a complete success.Photo:ESA/AOES Medialab

Some of the reasons for building Venus Express were that a mission like this could reuse much of the instruments and technologies that were developed for Mars Express and for Rosetta. Simultaneously, the scientific reason was that a mission to Venus would contribute to answers to some of the questions connected to the planet. Such recycling of developed technologies and experience have already provided results; the mission has to be carried out in a very short time compared to most scientific space missions, and to a relatively low use of resources. Now it remains to be seen whether the mission will be a complete success. It is an exciting time for all involved in the project.

When the space probe reaches Venus it has been 153 days on its way. During this time the probe's instrument and experiments have been checked out and the main engine has been used for correction of the course. Everything has functioned very well, and the next time the engine is used is when it is to set the Venus Express in the right direction for circling the planet.

Venus Express was launched from the Baikonur Cosmodrome in Kazakhstan on 9 November 2005. A Soyuz-Fregat rocket carried it into space and placed the spacecraft in its transfer orbit to Venus. The interplanetary cruise has taken 153 days and when it is captured by Venusian gravity, Venus Express will take additional 5 days to manoeuvre into its operational orbit: a 24-hour elliptical, quasi-polar orbit. At its closest, it will reach an altitude of 250 kilometres and at its furthest, it will be 66 000 kilometres away from the planet.

The mission to Venus was decided when ESA asked for proposals in March 2001, suggesting how to reuse the design of the Mars Express spacecraft. The guidelines were extremely strict. The mission would have to run to a tight timeframe because it had to reuse the same design as Mars Express, and the same industrial teams that worked on that mission should also be used for the new one. It would have to be ready to fly in 2005.

Out of a number of promising proposals, ESA selected Venus Express. What made the mission especially attractive was that many of the spare instruments developed for ESA's Mars Express and Rosetta missions could be used to achieve Venus Express's science objectives, which were to study the atmosphere in great detail.

Why Venus?

Venus is the Earth's nearest planetary neighbour. It draws twice as close to our planet as Mars will ever do. In terms of size and mass, Venus is Earth's twin and yet it has evolved in a radically different manner, with a surface temperature hotter than a kitchen oven and a choking mixture of noxious gases for an atmosphere.

In the past, both the Russians and Americans have sent spacecrafts to Venus. Being the closest planet to the Earth, it was a natural target. These studies revealed details about the surface of the planet, mainly from NASA's Magellan radar “Mapper”. However, Venus had been out of the limelight during the last decades, despite several scientific puzzles.

World of mysteries

One cannot understand the Venusian weather and atmosphere by comparing them to Mother Earth's. Scientists are unable to explain some of the more extreme atmospheric phenomena that take place on Venus. For example, the planet only rotates once every 243 Earth days. However, in the upper atmosphere, hurricane-force winds sweep around Venus, taking just 4 Earth days to circumnavigate the planet.

Several Nordic industrial companies have delivered hardware to Venus Express.

Building Venus Express

Several Nordic industrial companies have delivered hardware to Venus Express. This is the Danish Terma, the Swedish Saab Ericsson Space and the Norwegian Kongsberg Defence & Aerospace. In addition, the Aspera-4 instrument is developed and built at the Swedish Institute of Space Physics.

Venus Express with Danish Power

The Danish Terma has delivered both the Power Conditioning Unit and the Check- Out systems to Venus Express corresponding the same delivering to Mars Express and Rosetta.

A PCU is a vital unit on board the spacecraft. The unit interacts with the solar panels and the on-board batteries to provide the electricity to power the spacecraft navigation and communication systems and the scientific instruments. Because the power supply is the life nerve of the satellite all electronic circuits have built-in automatic back-up functions ("two-out-of-three redundancy") so the systems will still function if errors occur somewhere in the electric system.

The pover system from Terma.
Photo credit: Terma

The power is generated by the sun panels with an area of just under six square meters. During the night, the satellite is provided with power from batteries charged from the sun panels during the day.

The power supply on Venus Express is primarily a "reuse" of similar systems developed by Terma to the missions Mars Express and Rosetta. Today, this power unit has functioned perfectly. However, an update of the PCU was necessary due to different

Continues at the next page.

The surface of Venus also baffles scientists. The oldest craters seem to be only 500 million years old, which may indicate that the planet behaves like a volcanic pressure cooker, a pressure builds up inside the planet until the whole world is engulfed in a global eruption, resurfacing the planet and destroying any craters that have formed of impact of other bodies.

A set of key questions have been identified that formulate gaps in our current knowledge of Venus:

- What is the mechanism and what is the driving force of the super-rotation of the atmosphere?
- What are the basic processes in the general circulation of the atmosphere?
- What is the composition and chemistry of the lower atmosphere and the clouds?
- What is the past and present water balance in the atmosphere?
- What is the role of the radioactive balance and greenhouse effect in the past present and future evolution of the planet?
- Is there currently volcanic and/or tectonic activity on the planet?

The answers to these questions, together with other comprehensive studies under different themes can lead to an improved understanding of perhaps the most fundamental question of all: Why has Venus evolved so differently compared to Earth, in spite of the similarities in terms of size, basic composition and distance to the Sun?

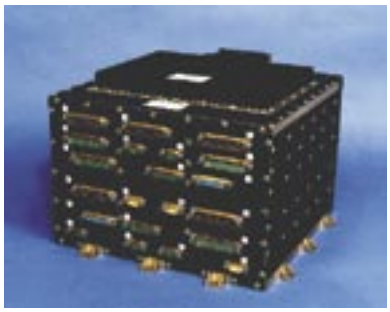
The Venus Express payload comprises a combination of spectrometers, spectro-imagers and imagers covering a wavelength range from ultraviolet to thermal infrared, a plasma analyser and a magnetometer. This set of instruments will be able to study the atmosphere, plasma environment and surface of Venus in great detail.

conditions on the Venus Express mission compared to Mars Express and Rosetta.

As the spacecraft will be exposed to extreme heat from Venus, it has been necessary to develop systems that can divert the extreme heat away from the spacecraft. On its journey around Venus, the temperature outside the satellite varies from about 200ºC on the day side and to minus 273ºC on the night side. Inside the probe, the temperature is kept at a constant room temperature in order for the electronics to function optimally. Terma provides advanced Power System solutions, which optimize power production, consumption and distribution depending on current satellite needs. The Power System is extremely reliable and operates independently of other satellite subsystems. With a small size and a weight of just 9 kilogram, it provides the optimal solution in compliance with the stringent constraints on overall size and weight of a satellite. The system is modular and is always tailored to the specific mission.

Test systems

Terma has in addition delivered systems for systematic tests of Venus Express functions before it is sent off into orbit. Through more than 25 years, Terma has developed these systems. They are built up around a special software core which is adapted to the individual scientific satellite. For this job a great understanding of how the satellite functions down to the last detail is necessary.



The Venus Express computer and the omnidirectional antenna for Telemetry and Telecom. Photo credit: Saab Ericsson Space

Antennas and onboard computer

On the long journey towards Venus, during the hopefully long time staying around the planet, management of the satellite and communication with Earth will be carried out by equipment developed, and built by Saab Ericsson Space. The company has developed a very reliable on board computer for such missions, originally developed for Rosetta, but also used at Mars Express. The computer shall manage all functions onboard in addition to hold control of their status during the mission. The computer gets order from Earth through an antenna, also developed and built at Saab Ericsson Space.

Space qualified computers with high reliability are the most well known product from the company, and constitute nearly half of the company's sale last year, while the antenna used for Venus Express is based on 25 years experience and first used at ESA's EXOSAT.

The right direction of the solar arrays. Solar Array Drive Mechanism from Kongsberg

Like most of the other equipmenttt onboard also the Solar Array Drive Mechanism is a well proven construction, originally designed for Rosetta, but also used at Mars Express. For Venus the construction is adjusted to this planet's surroundings, meaning that the solar arrays have lesser areas than for Mars Express, Venus is much closer to the Sun and receives a much more intense shine. Norwegian Kongsberg defence &Aerospaceis is responsible for this part of the construction, the two Solar Array Drive Mechanism (SADM) and the Solar Array Drive Electronics (SADE), which is subcontracted as a whole to Alcatel Espacio in Spain.

The main task for the SADM is to rotate the Solar Arrays and transfer the current from the rotating solar arrays into the spacecraft. To transfer the current from the rotating solar arrays to the static spacecraft a Twist Capsule is used which allows a +/- 180 degrees rotation of the electrical wires. An optical encoder measures the angular position and transmits the position to the SADE. The SADM is rotated by a stepper motor which is controlled from SADE.

The rotate mechanism for the solar arrays. Photo credit: Kongsberg Defence & Aerospace

Venus and Earth - like, but most unlike

Venus, the second planet from the Sun, lies, on average, 108 million km from the Sun, about 30% closer than the Earth. Venus is often referred to as our sister planet because of similarities in size, mass, density and volume. It is believed that both planets share a common origin forming at the same time out of a condensing nebulosity around 4.5 billion years ago.

There the similarities end.

Venus has no surface water, a toxic, heavy atmosphere made up almost entirely of carbon dioxide with clouds of sulphuric acid and at the surface the atmospheric pressure is over 90 that of the Earth at sea-level.

The surface of Venus is the hottest in the solar system at a searing 750 K (477 °C). This high temperature has been caused by a catastrophic greenhouse effect due to the carbon dioxide rich atmosphere. Incident sunlight is trapped by the atmosphere and cannot radiate out into space with a resulting boost to the surface temperature by over 475 K (202 °C).

The final anomaly between the two worlds is the rotation of Venus. Firstly its axis of rotation is inclined at 177.36 degrees (compared to 23.5 degrees on Earth). This means that Venus rotates from east to west, making the sun rise in the west and set in the east. Further to this a day of Venus lasts 243 Earth days, while a year is 224.7 Earth days.

Despite several missions to Venus there is still much that is unknown about our celestial neighbour. The Russian Venera landers touched down in the 1980s and survived the hostile environment for about 60 minutes during which time images were taken revealing a barren world. Other missions to Venus, both Russian Venera orbiters, and NASA's Magellan spacecraft have concentrated on radar mapping the surface.

From the data returned by these missions scientist believe that the surface of Venus is relatively young - it appears to have undergone resurfacing around 400 million years ago. The topography consists of vast plains (covered by lava flows) and mountainous regions.

Impact craters cover the surface. Unlike other worlds, however, there are virtually no craters less than 2 km in size. The impactors that would cause them simply burn up in the thick atmosphere. Those that do exist are believed to be caused by the fragmentation of a large meteorite just before impact with the surface.

Source: ESA/Venus Express