VENUS EXPRESS
Ground Segment
Summary Status at MERR

JPL, Pasadena: September 20, 2005

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Venus Express Ground
Segment Manager
ESA/ESOC (OPS-OP)
History of Venus Express

- Mission conceived in call for re-use of Mars Express spacecraft in 2001
- Proposal won a competition against 9 others
- Mission of Opportunity: Several existing experiments and spacecraft rebuild
- Started development in mid-2002
- Launch on October 26th, 2005
- EXPRESS = extremely short development time
Venus Express Science Goals

**Space environment:**
- Ionised plasma environment
- Interaction with solar wind

**Atmosphere:**
- Mechanisms of general atmospheric circulation
- Greenhouse effect
- Physics & chemistry of cloud layer
- Composition & chemistry of lower atmosphere
- Atmosphere-surface interaction

**Solid planet:**
- Surface IR topography
- Subsurface structure (few km)
Venus Express Instruments

ASPERA – Analyser of Space Plasmas and Energetic Atoms
S. Barabash, IRF Kiruna (SE)

VIRTIS - Visible and Infrared Thermal Imaging Spectrometer
G. Piccioni, Obs. Meudon (FR)

MAG - Fluxgate Magnetometer
T. Zhang, OAW Graz (AT)

SPICAV - Spectroscopy for the Investigation of Characteristics of the Atmosphere of Venus
J-L. Bertaux, CNRS Verrières (FR)

VMC – Venus Monitoring Camera
W. Markiewicz, MPAe Lindau (DE)

PFS - Planetary Fourier Spectrometer
V. Formisano, CNR Rome (IT)

VeRA – Venus Radio Science Experiment
B. Häusler, Univ.BW München (DE)
Venus Express “Firsts”

- Systematic long-term mapping (UV to thermal IR)
- Atmospheric temperature and dynamics at various levels (0 to 200 km altitude)
- Solar/stellar occultation techniques at Venus
- 3D ion mass analyser, Venus atmospheric escape
- Near-IR lower atmosphere and surface monitoring
- Subsurface radar sounding (few km)
- Reuse of spacecraft at another planet
Venus Express Spacecraft

- **Thermal control**
  - Venus Express Principles
  - Customised for Venus
  - Controlled heaters
  - Passive MLI & radiators

- **Structure**
  - Venus Express primary structure
  - Thruster kits for mobility
  - Attitude and orbit control
  - Outer shell heat shield

- **Attitude control and measurement**
  - Venus Express release
  - Three-axis stabilized using three 12-axis reaction wheels
  - Two-wide field of view star trackers with autonomous Sun Pattern recognition and measurement capabilities
  - Two inertial measurement units including three ring laser gyros and three accelerometers each
  - Two-axial sun sensors

- **Power**
  - Venus Express with solar panels
  - Fully regulated 24V bus
  - Maximum power from tracking
  - 160 watts peak power for Venus operations
  - 1 L solar batteries 4 km
  - 3 kW Power Control Unit for power distribution and protection
  - 3652 solar cells Power Control Unit for pyramids

- **Data handling**
  - Venus Express
  - SSA (Spacecraft) architecture
  - Two Command & Data Management Units providing:
    - 1.37 Gbps throughput for ACES & BMS
    - Interchangeable modules with majority voting redundancy
    - Transfer frame generation up to 1 Gbps
    - 12 Mb/s Solid State Mass Memory
    - REE 1333 Mb/s for high data rate transfers

- **Telecommunications**
  - Venus Express
  - B - band (1400 MHz) radio
  - 1.2 meter diameter fixed S-band (9800 MHz) antenna
  - 2595 mm diameter fixed C-band (4000 MHz) antenna
  - 6x 12W transmitters
  - Dual 650 MHz transponders (50 watts RF)

- **Propulsion**
  - Venus Express
  - Available for three years
  - Bi-propellant system
  - RCS thrusters for attitude control
  - Over 3000 pounds of propellant
  - Pressure regulated and low dead band operational mode
  - Eight 10K thrusters drivers
  - One 400K thrust engine

- **On-board software**
  - Venus Express
  - RIS-65-5 standard OASIS
  - Integrated ACS and BMS functions
  - Modular design
  - Top level object oriented design
Venus Express Launch Service

- Launch from Baikonur, Kazakhstan (1270 kg)
- Soyuz rocket to ballistic trajectory
- Upper stage (FREGAT) burn to circularise then 2nd burn to Venus injection
- Separation about 90 minutes after lift-off
- LEOP for 3 days
Ground Segment Overview

**Venus Express Mission Operations Centre (VMOC)**
- **SIM** System Simulator
- **FDS** Flight Dynamics System
- **MCS** Mission Control System
- **DDS** Data Disposition System
- **MPS** Mission Planning System

**Venus Express Science Operations Centre (VSOC)**
- **Science Planning / Commanding**
  - Interface to VMOC/ESOC
  - Scientific Mission Planning
  - Consolidation of PI Command Requests
- **Data Handling and Archive System**
  - Scientific Data Handling
  - Scientific Data Archive
  - Archive Structure, Data Labels
  - WWW User Interface

**Key Sites**
- **Cebreros 35m**
- **New Norcia 35m**
- **Kourou 15m** (DSN back-up)

**Additional Systems**
- **SWT** Science Working Team
- **PIs** Principal Investigators

**Organizations**
- **esae**
- **Venus Express Mission**
- **European Space Agency**
- **Agence spatiale européenne**

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Cebreros
(Avila Spain)
June 2005
Venus Express Mission Overview

- Launch and Early Orbit Phase (LEOP) for 3 days
- Near Earth Verification for 4 weeks
- Interplanetary Cruise for 5 months
- Injection into operational orbit of 24 hours (April 2006)
- Operations for 2 Venus Days (486 earth days) using a Look-Record-then playback operations scenario
Mission Details

Major Events / Mission Phase | Nominal Date
--- | ---
Launch | 26 October 2005 (04:40 UTC)
Cruise Phase
Start Near Earth Commissioning | 2 November 2005
Trajectory Correction #1 | 3 November 2005
End Near Earth Commissioning | 22 November 2005
Mid-course Correction | 23 December 2005
Attitude adjustment for Venus Capture | 29 March 2006
Venus Orbit Insertion (VOI) Phase
Start VOI | 8 March 2005
Venus Capture Maneuver (ΔV 1300 m/s) | 6 April 2006
Apocenter Lowering (ΔV 285 m/s) | 11 April 2006
Venus Commissioning Phase
Start of Venus Orbit Commissioning (Payload) | 12 April 2006
End of Venus Orbit Commissioning | 26 May 2006
Routine Operations Phase
Start of Science Operations | 27 May 2006
End of Eclipse Season #1 | 31 May 2006
Eclipse Season #2 (max. 51 min) | 6/8/2006 – 10/9/2006
Earth-Venus superior Conjunction (communications outage) | 1 November 2006 (19 Oct – 9 Nov 2006)
Eclipse Season #3 (max. 36 min) | 16/11/2006 – 6/1/2007
Start of Venusian Day #2 | 21 January 2007
Eclipse Season #5 (max. 36 min) | 2/7/2007 – 17/8/2007
End of Mission (baseline) | 24 September 2007
Extended Mission Phase (optional)
Start of Extended Mission | 25 September 2007
End of Extended Mission | 22 January 2009
NASA/DSN Interface Status

- Use of the NASA/DSN agreed for
  - Venus Orbit Insertion (VOI) support, in particular delta-DOR and 70m coverage during Venus capture
  - LEOP support (3 days)
  - Back-up support during cruise

- Pertaining implementation documentation has been signed by ESA and JPL (November 2004) and actual implementation testing is well advanced

- Letter of Agreement (LOA) now signed (17-Jun-05)

- No provisions made to date for DSN VeRA support during routine mission. This is agreed with parties concerned
NEXT STOP VENUS

VENUS EXPRESS

Venus Express Mission

European Space Agency
Agence spatiale européenne