THE MARS EXPRESS/NASA PROJECT AT JPL

T. W. Thompson, R. L. Horttor, C. H. Acton, Jr.,
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Lunar and Planetary Science Conference
17 March 2005
Mars Express/NASA Project
Project Overview

Mars Advanced Radar for Subsurface and Ionospheric Sounding (MARSIS):
- MARSIS Antenna Deployment in late April to be followed by Commissioning and key observations of the South Pole

Science Support: Provides for U.S. science participation in Mars Express:
- By funding U.S. Co-Investigators, Participating Scientists and Interdisciplinary Scientists on Mars Express HRSC, OMEGA, PFS, Radio Science, SPICAM, and MARSIS Experiments
- By developing NAIF-SPICE as well as MIPL Telemetry and Archiving Software that support delivery of Mars Express scientific data to PDS

Telecom Interoperability: Conduct Communication Interoperability Studies and design tests to ensure interoperability of NASA and ESA assets at Mars - DONE - Successfully demonstrated

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Navigation Assurance: Conducted Joint ESOC-JPL Navigation Campaign in Cruise - DONE

ASPERA 3: Design, Construction, and Delivery of ASPERA-3 Electron and Ion Spectrometers to Swedish Institute of Space Physics. Funded under the Discovery Program.
Mars Express/NASA Project Personnel

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Richard L. Horttor (richard.l.horttor@jpl.nasa.gov)

Mars Express/NASA Project Science Manager
Thomas W. Thompson (thomas.thompson@jpl.nasa.gov)

MARSIS Instrument Manager
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MARSIS Co-PI
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NASA Headquarters Program Executive
David Lavery (dave.lavery@hq.nasa.gov)

NASA Headquarters Program Scientist
Steve Saunders (stephen.saunders@nasa.gov)
# MARS EXPRESS MISSION EXPERIMENTS AND INVESTIGATORS

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<td>PFS</td>
<td>Dr. V. Formisano, Instituto Fisica Spazio Interplanetario</td>
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<td>Atreya, Univ. of Michigan</td>
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<td>ASPERA-3</td>
<td>Discovery Program provides Electron Spectrometer (EIS) and portions of the Ion Mass Analyzer</td>
<td>Prof. Dr. R. Lundin, Swedish Institute of Space Physics</td>
<td>EIS PI is D. Wimingham of SwRI</td>
<td>Sandel, UAZ, Curtis, UAZ, Hseih, UAZ, Kozyra, Univ of Michigan, Luhmann, UCLA, Williams, APL, Roelof, JHU, Scharber, SwRI, Frahm, SwRI, Williams, JHU</td>
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<td>HRSC</td>
<td>Prof. Dr. C. G. Neukum, Freie Universitaet, Berlin</td>
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<td>Carr, USGS, Kirk, USGS, Duxbury, JPL (IDS), Greeley, ASU, Head, Brown, McCord, PSI, Squyres, Cornell</td>
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<td>Germany</td>
<td>MaRS</td>
<td>Prof. Dr. M. Paetzold, University of Cologne</td>
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<td>Tyler, Stanford Univ, Simpson, Stanford (TM), Hinson, Stanford (TM), Asmar, JPL (IS)</td>
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Mars Express-NASA Project

OVERVIEW

ESA's Mars Express Mission

- Orbiter supplied by ESA
- Seven Instruments from five countries and U.S.
- Radar Sounder by U.S. and Italy is new
- Launched on June 2, 2003
- Arrived December 25, 2003
- Prime mission is one Mars year
- Extended mission includes an additional Mars year

- NASA/JPL Contributions to Mars Express
  - **MARSIS Instrument**: Radar Sounder MARSIS Managed by JPL with Antenna, Transmitter and RF Subsystems furnished by U.S. (Joint 50-50 effort with Italians)
  - **Science**: 25 U.S. Investigators on European Experiments - HRSC and NAIF-SPICE Software
  - **DSN Tracking Support**: Additional Downlink, Radio Science, Cruise Navigation
  - **Telecom Interoperability**: Demonstrated Mars Express-MER UHF Link
  - **Navigation Assurance**: Joint ESOC-JPL Navigation in Earth-Mars Cruise
  - **Aspera-3**: Electron/Ion Spectrometers funded by Discovery
Mars Advanced Radar for Subsurface and Ionospheric Sounding (MARSIS) Overview

Salient Features

- Joint NASA/JPL - ASI/Alenia Spazio Project
- JPL responsible for RF subsystem, Alenia responsible for Digital subsystem plus MARSIS & System level integration
- NASA/JPL Hardware Contributions: RX from JPL, TX from Univ. Iowa, Antennas from TRW Astro Aerospace
- Mass = 15 kg / Power = 60 W / Main Antenna 40 m dipole
- Deliver EM-Like Units to ASI - October 2000
- Deliver Flight Units to ASI - August 2001
- Flight Acceptance Review - late-2001

Scientific Objectives

Primary - To map the distribution of water, both liquid and solid, in the upper crust of Mars.
1. Detect and map subsurface liquid water.
2. Map distribution and thickness of ice-saturated layers
3. Measure thickness, structure and properties of polar deposits.

Secondary
- Detect and map geologic units and structures in the third dimension.
- Characterize surface properties: elevation, roughness, and radar reflectivity.
- Probe the ionosphere of Mars to study the interaction of the atmosphere and solar wind.

Measurement Capabilities

- Resolution:
  Better than or equal to 10 km lateral (footprint size).
  Better than or equal to 100 m depth.
- Coverage:
  Global at < 10 km footprint spacing.
  Polar coverage is desirable.
- Depth of water layer detection:
  > 5 km under favorable conditions.
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MARSIS is an orbital low-frequency (1.3 MHz – 5.5 MHz) sounding radar that provides echo profiles of the subsurface of Mars to several kilometers deep. It also operates in an ionospheric sounding mode (0.1 MHz-5.5 MHz) to observe the interaction of the solar wind and the upper atmosphere of Mars.

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MARSIS provides the first opportunity to probe the subsurface to several kilometers deep and directly detect liquid water.

If aquifers are present in the upper ~ 3 km of the crust, we expect to see a radar signature. Liquid water provides a uniquely high contrast in dielectric properties compared with surrounding rocks.

Detecting the presence/absence of ice will be more difficult; likewise other geologic contacts, due to smaller dielectric contrasts. However, many interfaces are likely to be mapped, some of which are related to relict or current hydrologic processes.

Near-surface aquifers may be present due to active thermal processes or low-thermal-conductivity sediments. Detection of these sites could provide targets for future in situ life and water resource exploration.
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Swath Mapping

Single Footprint

Time (Depth)

Power

~ 500 contiguous footprints per orbit

Up to 4 profiles for each footprint

10 km
Mars Express/NASA Project

INTEROPERABILITY CONCEPT

NASA ORBITING COM ELEMENTS:
M'01 Orbiter

ESA ORBITING COM ELEMENTS:
Mars Express

NASA LANDED ELEMENTS:
MER'03 Landers

ESA LANDED ELEMENTS:
Beagle 2

Current focus of this Task
MARS EXPRESS SCHEDULE (2003 – 2007)

- LAUNCH (02 JUNE '03)
- MOI (25 DEC '03)
- TRANSITION TO MAPPING ORBITS (JAN '04)
  - ECLIPSES (MID – FEB '04)
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  - PRIME MISSION
    (1st MARS YEAR)
- MARSIS ANTENNA DEPLOY / CHECK-OUT (MAY '05)
- EXTENDED MISSION
  (2nd MARS YEAR)
- DATA RELEASE - EVERY 6 MONTHS

2003 | 2004 | 2005 | 2006 | 2007

Version 1 — 02 Mar '04
Mars Express Science Operations

Science Data Downlink
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Current focus of this Task
# MARS EXPRESS SCHEDULE (2003 – 2007)

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Version 1 — 02 Mar '04
Mars Express Science Operations

Science Data Downlink

- Sun elev. > 60
- 15 < Sun elev. < 60
- -15 < Sun elev. < 20
- Sun elev. < -15

Data volume (MB/day)

TIME (days)

eesa