Status of ESA’s Mars Activities

MEPAG meeting
Washington DC, 13-14 May 2014

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Robotic Exploration Coordination Office
Science and Robotic Exploration Directorate

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Mars Exploration at ESA

- TGO and EDM
- ExoMars
- Rover + Platform
- PHOOTOPRINT
- INSPIRE
- MSR elements

Mars Express

2003 to 2030+
Mars Express Mission:
Status and near future milestones

- **Status:**
  - Spacecraft and payload status: very good
  - Fuel estimates enough for a few more years.
  - 29 December 2013: closest ever flyby of Phobos (~ 45 km).

- **Near future milestones**
  - 19 October 2014: Siding Spring comet flyby (distance ~ 135,000 km)
  - October 2016: Mars Express relays data from the ExoMars entry and descent module
ExoMars Programme

Two missions launched in 2016 and 2018, respectively

- The 2016 flight segment consists of a **Trace Gas Orbiter (TGO)** and an **EDL Demonstrator Module (EDM) - Schiaparelli**
- The 2018 flight segment consists of a **Carrier Module (CM)** and a **Descent Module (DM)** with a **Rover** and a stationary **Surface Platform**
2016 Mission Objectives

TECHNOLOGY OBJECTIVE
- Entry, Descent, and Landing (EDL) of a payload on the surface of Mars.

SCIENTIFIC OBJECTIVE
- To study Martian atmospheric trace gases and their sources.
- To conduct surface environment measurements.
- Provide data relay services for landed missions until 2022.
2018 Mission Objectives

TECHNOLOGY OBJECTIVES
- Surface mobility with a rover (having several kilometres range);
- Access to the subsurface to acquire samples (with a drill, down to 2-m depth);
- Sample acquisition, preparation, distribution, and analysis.
- Qualification of Russian ground-based means for deep-space communication
- Adaptation of Russian on-board computer for deep space missions and ExoMars landed operations
- Development and qualification of throttleable braking engines for prospective planetary landing missions

SCIENTIFIC OBJECTIVES
- To search for signs of past and present life on Mars:
- To characterise the water/subsurface environment as a function of depth in the shallow subsurface.
- To characterise the surface environment.
Current status

ExoMars programmatic status

- ESA – Roscosmos ExoMars agreement in force (14 March 2013)
- Revised Science Management Plan approved (February 2014)

2016 ExoMars Mission (TGO and EDM)

- Contract signed with Industry for full development, launch and operations
- Operations and science ground segment in development
- System Critical Design Review (S-CDR) board meeting on 18-4-2014 concluded no show stoppers but requested further reporting on some issues
- 2016 mission on schedule with limited margins
- Effect of US State Department block on Export Licences still tbd

2018 ExoMars Mission (CM, DM, Rover)

- The 2018 mission is in Phase B (CM, DM), while the Rover is in Advanced CD
- System Requirements Review (SRR) close-out on 17 December 2013
- Landing Site Selection process kicked-off in December 2013 (see JV presentation)
- AO for Surface Platform instruments in preparation (Q2 2014 tbc)
- Descent Module Design Project Review ongoing (March-June 2014)
- System Preliminary Design Review (S-PDR) in preparation (May-July 2014)
- Full Industrial Proposal expected in Q3 2014
The Mars Robotic Exploration Preparation Programme (MREP)

- Mission studies for post-ExoMars missions
  - PHOOTPRINT, INSPIRE, MPL-SFR, ..

- Exploration Technology Development
  - Mission specific technologies
  - Long-term enabling technologies (Nuclear Power Systems, Advanced Propulsion)
  - General MSR preparatory technology activities (eg. sampling, PP related technologies, sample rendezvous and capture, precision landing, ...)

- MREP phase 2 ongoing, open for new subscriptions at C-MIN 2014
Technology development activities are implemented in ESA Mars Robotic Exploration Preparation Programme (MREP) and focused on specific themes:

- MSR Orbiter, including Orbiting Sample capture and biosealing in orbit, and Earth Return Capsule
- Sample fetch rover: Small rover (100 kg) with high surface mobility
- Precision landing on Mars: development of a capability to deliver 300 kg to Mars surface with a precision better than 10 km
- Sample receiving facility
PHOOTPRINT Mars-2024 candidate

- **Return a sample of ~100 g from Phobos**
- **Reference Payload ~35 kg**
  - Cameras, VIS-NIR and Mid-IR spectrometers
  - Heritage from Rosetta, VEX and Bepi-Colombo
- **High and recognised intrinsic science value**
  - Origin and formation of Phobos; Solar System evolution
- **Prepares critical building blocks for MSR**
  - Sampling, transfer and sealing
  - Short range Rendezvous
  - Earth Return Capsule
  - Sample receiving facility
- **Possible scenarios for cooperation with Roscomos identified**
  - CDF study on joint mission on-going April-May 2014
  - Industrial phase A/B1 study in 2014 / 2015
  - Implementation proposal C-MIN 2016 (tbc)
Other candidate missions: INSPIRE and MPL

- Network of 3 surface elements for Mars interior and atmosphere characterisation.
- Timely after InSight and with potential of TGO being available
- Mature Payload, ~ 15 kg
- Seismometer, Mole with Heat Flow and Physical Properties Probe, Meteorological Boom, Radio-Science Package and Camera
- Heritage from ExoMars/Humboldt and Insight developments

- Soyuz launch of a Mars Precision Lander (MPL) + small science rover (10 km landing site accuracy)
- Explore a new region of Mars to investigate the (hydro-)geologic history, and habitability potential, taking benefit of high mobility
- Rover mobility > 170 m/sol capability, 3.5 to 5 hours available to drive per sol. GNC high mobility algorithms developed by MREP
- MSR preparation: MPL could be a segment of MSR Campaign, delivering the sample fetch rover
Back-up slides
**CaSSIS**
High-resolution, stereo camera

**NOMAD**
High-resolution occultation and nadir spectrometers

**UVIS**
(0.20 – 0.65 µm) \( \lambda/\Delta\lambda \sim 250 \)

**IR**
(2.3 – 3.8 µm) \( \lambda/\Delta\lambda \sim 10,000 \)

(2.3 – 4.3 µm) \( \lambda/\Delta\lambda \sim 20,000 \)

**FRIEND**
Collimated neutron detector

**Mapping of sources**
Landing site selection

**Mapping of subsurface water**
And hydrated minerals

**Atmospheric composition**
(CH\(_4\), O\(_3\), trace species, isotopes)
dust, clouds, P&T profiles

**Atmospheric chemistry, aerosols,**
surface T, structure
### Pasteur Payload

<table>
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<tr>
<th>Instrument</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>PanCam</strong></td>
<td>Wide-angle stereo camera pair&lt;br&gt;High-resolution camera&lt;br&gt;<strong>Geological context</strong>&lt;br&gt;<strong>Rover traverse planning</strong>&lt;br&gt;<strong>Atmospheric studies</strong>&lt;br&gt;WAC: 35° FOV, HRC: 5° FOV</td>
</tr>
<tr>
<td><strong>ISEM</strong></td>
<td>IR spectrometer on mast&lt;br&gt;<strong>Bulk mineralogy of outcrops</strong>&lt;br&gt;<strong>Target selection</strong>&lt;br&gt;λ = 1.15 – 3.3 μm, 1° FOV</td>
</tr>
<tr>
<td><strong>CLUSI</strong></td>
<td>Close-up imager&lt;br&gt;<strong>Geological deposition environment</strong>&lt;br&gt;<strong>Microtexture of rocks</strong>&lt;br&gt;<strong>Morphological biomarkers</strong>&lt;br&gt;20-μm resolution at 50-cm distance, focus: 20 cm to ∞</td>
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<tr>
<td><strong>WISDOM</strong></td>
<td>Ground-penetrating radar&lt;br&gt;<strong>Mapping of subsurface stratigraphy</strong>&lt;br&gt;3 – 5-m penetration, 2-cm resolution</td>
</tr>
<tr>
<td><strong>FREN</strong></td>
<td>Passive neutron detector&lt;br&gt;<strong>Mapping of subsurface stratigraphy</strong>&lt;br&gt;<strong>Water and hydrated minerals</strong></td>
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<tr>
<td><strong>Drill + Ma_MISS</strong></td>
<td>In-situ mineralogy information&lt;br&gt;IR borehole spectrometer&lt;br&gt;λ = 0.4 – 2.2 μm</td>
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### Analytical Laboratory Drawer

<table>
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<th>Instrument</th>
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<tr>
<td><strong>MicrOmega</strong></td>
<td>VIS + IR Spectrometer&lt;br&gt;<strong>Mineralogical characterization of crushed sample material</strong>&lt;br&gt;<strong>Pointing for other instruments</strong>&lt;br&gt;λ = 0.9 – 3.5 μm, 256 x 256, 20-μm/pixel, 500 steps</td>
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<tr>
<td><strong>RLS</strong></td>
<td>Raman spectrometer&lt;br&gt;<strong>Geochemical composition</strong>&lt;br&gt;<strong>Detection of organic pigments</strong>&lt;br&gt;spectral shift range 200–3800 cm⁻¹, resolution ≤ 6 cm⁻¹</td>
</tr>
<tr>
<td><strong>MOMA</strong></td>
<td>LDMS + Pyr-Dev GCMS&lt;br&gt;<strong>Broad-range organic molecules at high sensitivity (ppb)</strong>&lt;br&gt;<strong>Chirality determination</strong>&lt;br&gt;Laser-desorption extraction and mass spectroscopy&lt;br&gt;Pyrolysis extraction in the presence of derivatisation agents, coupled with chiral gas chromatography, and mass spectroscopy</td>
</tr>
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MREP Technology Development Overview

Earth Return Capsule developments

Sample Capture and biosealing in orbit developments

Precision Landing equipment: Inertial Measurement Unit, altimeter miniaturisation

1 kN bi-liquid engine development for Mars insertion

Sample Fetch Rover and high mobility demonstration

Nuclear Power Sources RHU & RPG, based on Am(241) radioisotope