Mars Robotic Exploration Preparation Programme

MREP 2

MREP 2 - Missions

2016 + 2018 ExoMars = - A component of the European Space Exploration Programm"Aurora"

Scientific objectives:

1. **To search for signs of past and present life on Mars;**
2. **To investigate the water/geochemical environment as a function of depth in the shallow subsurface;**
3. **To study Martian atmospheric trace gases and their sources.**

The ESA Rover → 1+ 2

The ESA Orbiter → 3

2022 + 2024 – INSPIRE and PHOOTPRINT

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2016 Mission

The spacecraft will be launched in early January 2016 by NASA

ESA will design and build a large spacecraft which will carry **an Entry, Descent and Landing (EDL) Demonstrator** and go into orbit around Mars to perform a primary science mission of 2 Earth years followed by a primary Mars proximity and deep space communications mission of at least 3 years.

The communications portion of the mission will support **the 2018 rover mission** and subsequent international assets on the surface of Mars. Prior to arrival at Mars the ESA EDL Demonstrator will be ejected from the spacecraft and will enter the Mars atmosphere from a hyperbolic arrival trajectory.

The science instruments on-board will remotely sense the presence, quantity and potential sources of methane in the Martian atmosphere.

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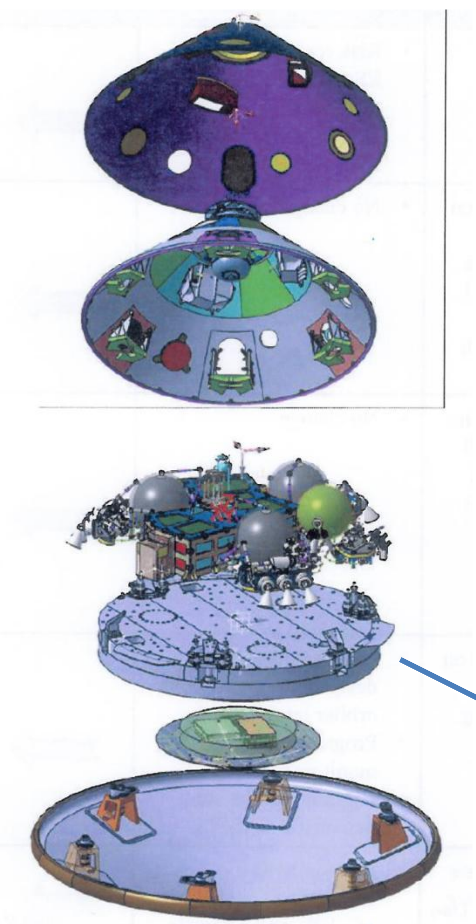
EDM exploded view



Entry, Descent and Landing Demonstrator Module

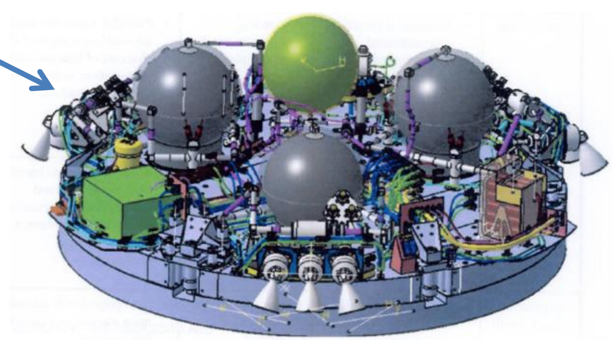
Trace Gas Orbiter science instruments

NOMAD – High-resolution occultation and nadir spectrometers (Atmospheric composition, dust, clouds)

CaSSIS – High-resolution, stereo camera (Mapping of sources, Landing site selection)

ACS – 3 high-resolution spectrometer

FREND – Collimated neutron detector (Mapping of surface water and hydrated minerals)



Main Panel

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Orbiter Scientific Objectives

- Detection of a broad suite of atmospheric trace gases (with high sensitivity)
- Characterisation of their spatial and temporal variation
- Localisation of sources of key trace gases?

Orbiter Scientific Measurements

- Solar occultation and nadir mapping measurements
- Thermal emission measurements:
- Visual monitoring of atmospheric phenomena
- High-resolution surface imaging

2018 Mission

Scientific Objectives for 2018 Mission:

- 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

Technology Objective for 2018 Mission:

- Surface mobility with a rover (having several km range)
- Access to the subsurface to acquire samples

  (with a drill, down 2 m depth)
- Sample acquisition, preparation, distribution, and analysis

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Analytical Laboratory Drawer (ALD)

MicrOmega (VIS + IR Spectrometer)– Mineralogical characterization of crushed sample material

RLS (Raman spectrometer) Geochemical composition, Detection of organic pigments

MOMA - Broad-range organic molecules at high sensitivity

The MOMA instrument provides novel techniques for measuring and characterizing organic molecules, by combining laser desorption and ionization with Ion Trap Mass Spectrometry and Pyrolysis.

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Orbiter Scientific Objectives

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Orbiter Scientific Measurements

- ➢ Solar occultation and nadir mapping measurements
- ➢ Thermal emission measurements
- ➢ Visual monitoring of atmospheric phenomena
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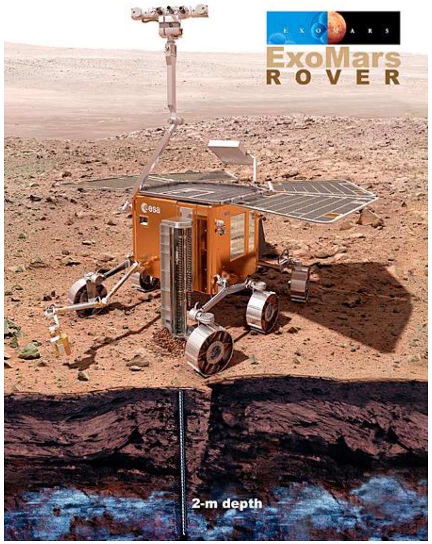

2-m depth Drill

Determine rover's geological context:

- Survey site at large scales — Panoramic Instruments
- Examine surface outcrops and soils at sub-mm scales — Close-Up Instruments

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Collect a subsurface (or surface) sample

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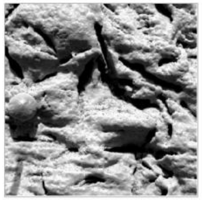
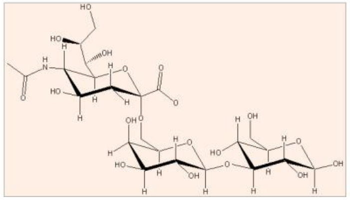
Study sample:

- Survey analysis — Analytical Laboratory
- Detailed analysis





Scale

The ExoMars Rover surface exploration scenario

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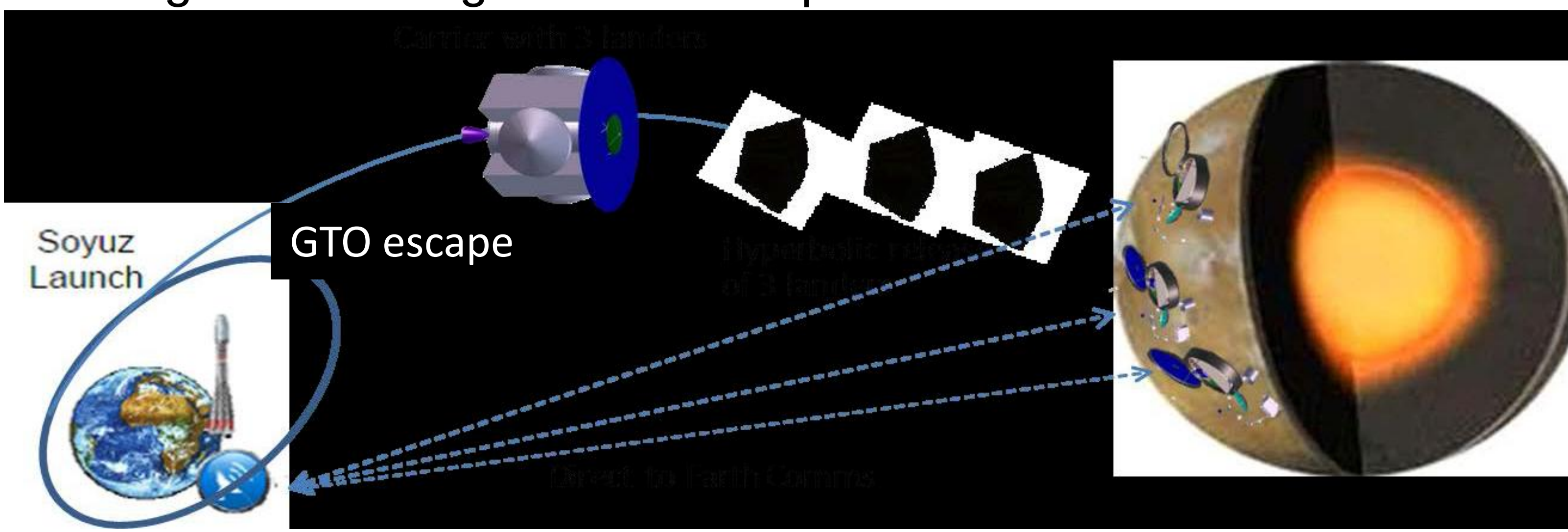
Post-ExoMars missions target 2022/2024 opportunities

I. The **Network Science mission** (INSPIRE)

aiming at delivering a network of probes on the surface of Mars to



The decision for full implementation and the budget for the first mission are expected at the 2015 ESA Council at Ministerial Level.

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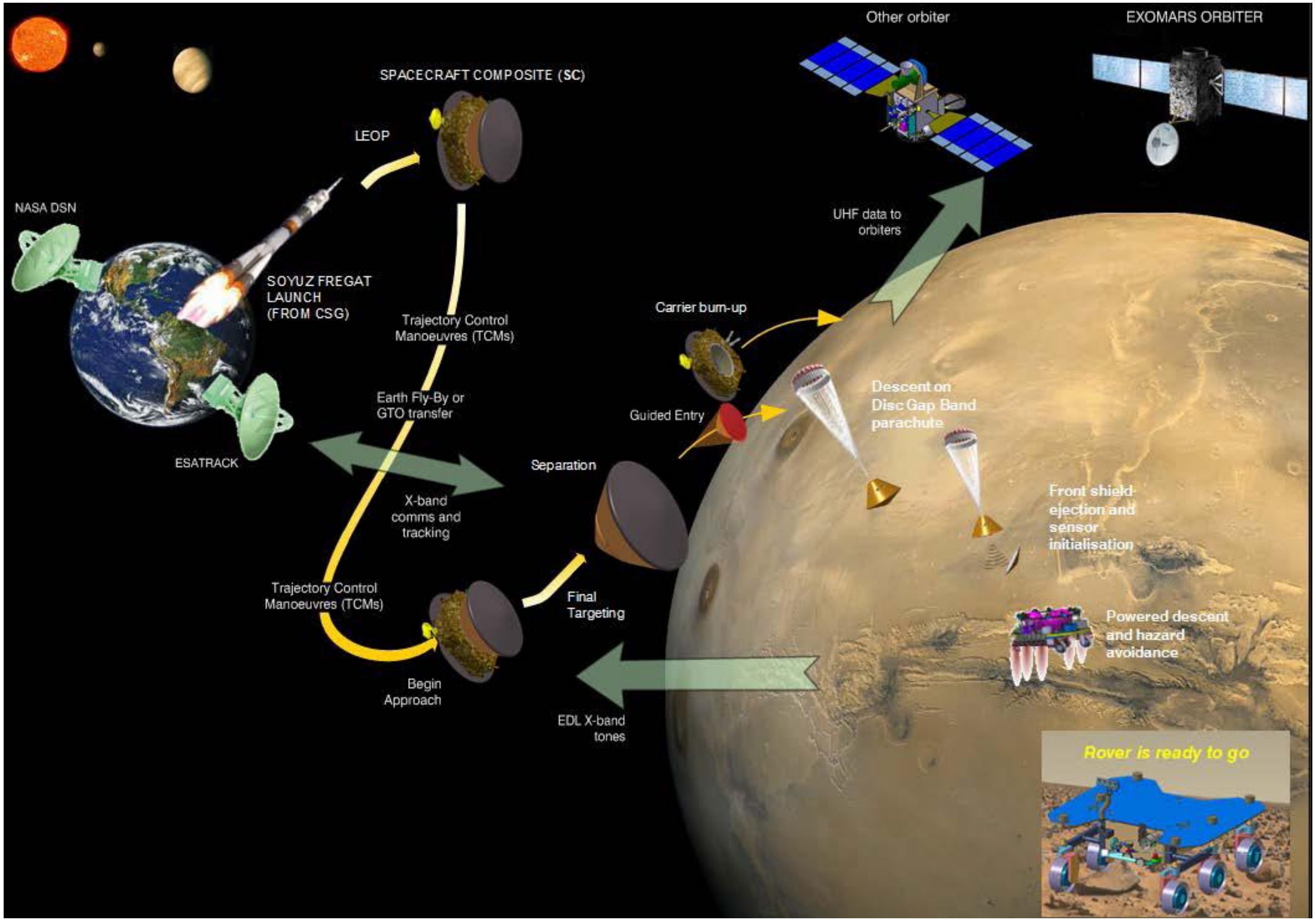

Mars Precision Lander mission scenario

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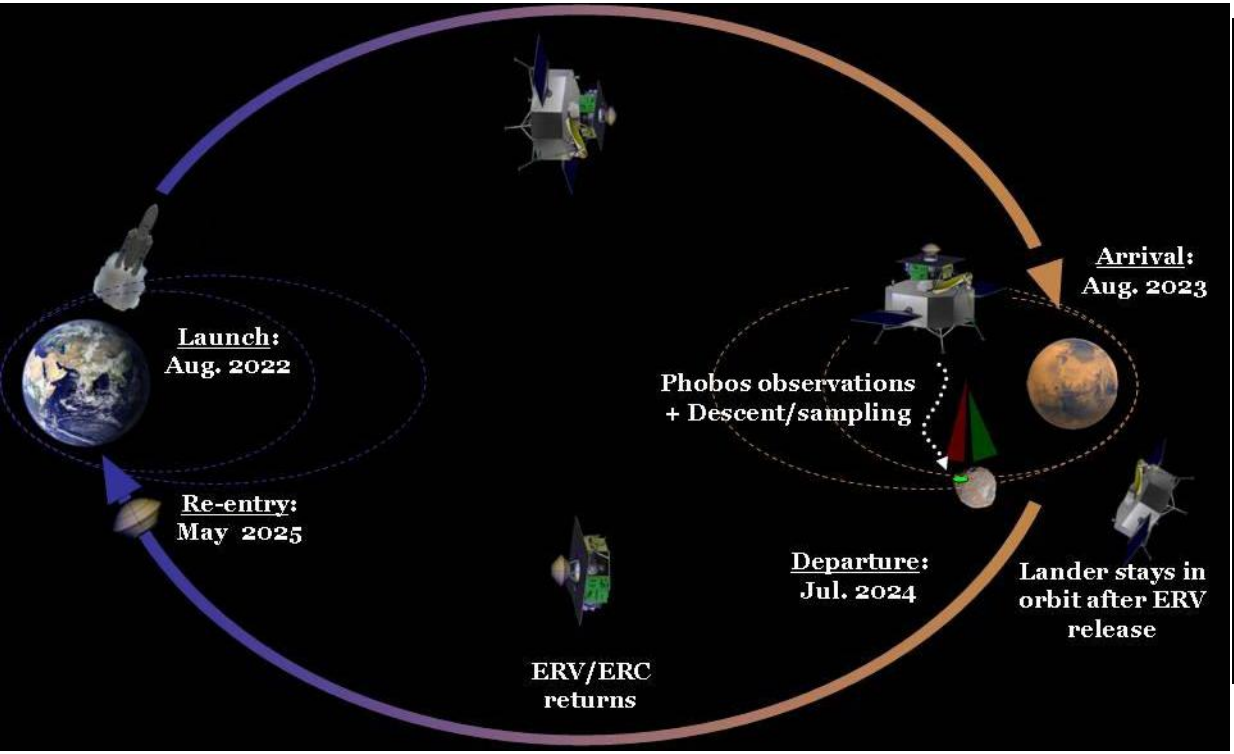
Preliminary identification of critical technologies for INSPIRE requiring pre-developments to TRL6 for securing 2022 launch

- Thermal design verification of the surface platform, in particular for the warm electronics box
- Airbag System testing
  - o Inflation testing with representative interfaces
  - o Impact testing under relevant environments
  - o Airbag jettisoning/retraction
- Surface platform mechanical deployment:
  - o Detection of rest state
  - o Clamshell opening and self rightning mechanism
  - o Solar panel deployment
  - o Robotic arm deployment and instrument deployments (Seismometer and Mole)
  - o High Gain antenna pointing for direct-to-Earth communication
- Direct-to-Earth communication
- Lander Lowering
- Retrorockets firing
- Altimeter flight tests

II. The Mars Moon Sample Return (PHOOTPRINT)

aiming at returning a sample from a moon of Mars **- Phobos.**



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The spacecraft main elements

1. **The orbiter/lander** carrying the ERV/ERC, performing the transfer to Mars, the Mars orbit insertion and operations around and on Phobos including landing and sampling, left around Phobos/Mars.

2. **The Earth Return Vehicle** (ERV) performing Mars escape, transfer back to Earth and ERC release few hours before re-entry.

3. **The Earth Re-entry Capsule** (ERC) with hard landing on Earth.

Preliminary identification of critical technologies for PHOOTPRINT requiring pre-developments to TRL6 for securing 2024 launch

- System for descent and landing on Phobos: operational software and camera/radar altimeter Engineering Qualification Models (EQM) on robotic arm simulator

- End-to-end sampling, sample handling, transfer and sealing chain. EQM level targeted, with verification using parabolic flights and ground tests in vacuum.

- Landing system, possibly with verification in simulated micro-gravity environment (LAMA crane of DLR for instance) with EM crushable legs

- Full system demonstration of the Earth Re-entry Capsule hard landing, i.e. drop test verifications of the actual ERC design, possibly with the recovery system included

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Payload

- Seismometer,
- heat flow probe & physical properties package,
- atmospheric instrument on a boom,
- radio-science package, camera

Key Challenges & Technology

- Multiple probes delivery, with second generation landers (vs ExoMars EDM) featuring higher payload to entry mass ratio,
- New airbag landing system allowing small landers (<500kg).
- Surface operations with robotic systems
- Long term survival on Martian surface

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The outcome of the feasibility studies will be presented to the PB-HME, including the programmatic assessment, and the decision on the mission to proceed in Phase B1 under MREP-2 will be taken by **the Participating States to MREP-2** by simple majority, subject to Participating States affordability and taking into account the evolution of the overall Mars exploration context.

Parallel industrial contracts will be foreseen for the Definition Phase activities for the selected mission for 2022 or 2024 launch opportunity and will be awarded through open competition restricted to the Member States participating to the programme.

The use of parallel contracts will:

- enhance the quality of the technical work
- provide maximum flexibility for the project future implementation

MREP-2 key milestones

Item	Start (or issue date when applicable)
Industrial contracts kick-off for the Phase A studies for the candidate missions	June 2013
First technology work plan	Q2 2013
Instrumentation AO for 2022 mission	Q1 2014
Work plan for predevelopment activities for 2022 missions	Q2 2014
Selection of the candidate mission to proceed in Phase B1	Q3 2014
Start of predevelopment industrial contracts for 2022 mission	Q4 2014
Go-ahead decision on Nuclear Propulsion Sourse (NPS) and fuel production facility	Q1 2015