2018 Joint Rover Objectives

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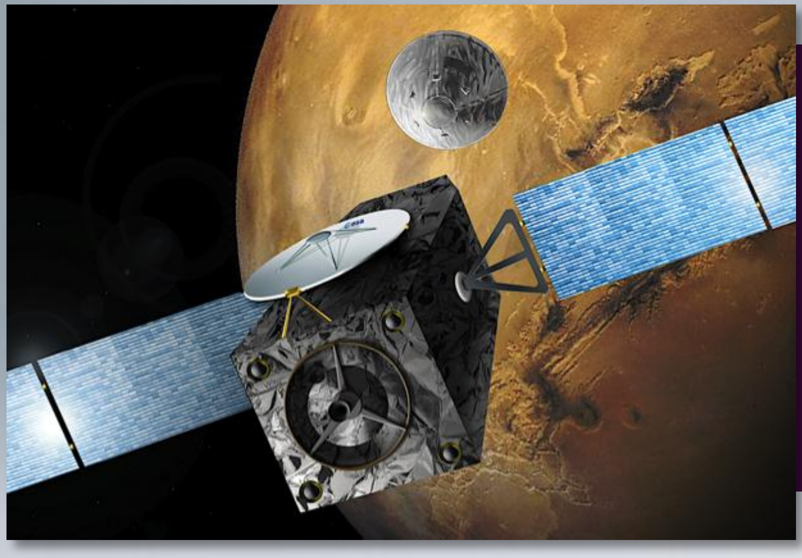
MEPAG
16 June 2011, Lisbon (P)

Programme Building Blocks

- ESA and NASA have agreed to embark on a joint Mars robotic exploration programme:
  - Initial missions have been defined for the 2016 and 2018 launch opportunities;
  - Missions for 2020 and beyond are in a planning stage;
  - The joint programme's ultimate objective is an international Mars Sample Return mission.

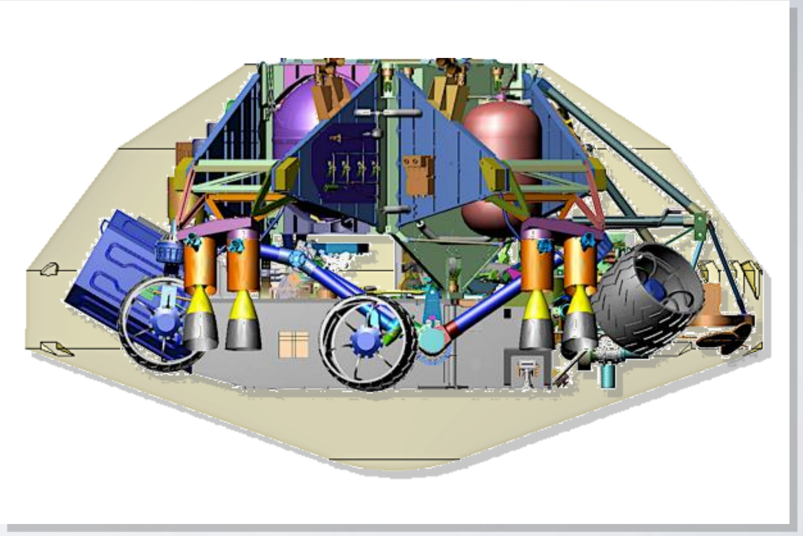


2016 ESA-led mission

Launcher:	NASA – Atlas V 431
Orbiter:	ESA
Payload:	NASA-ESA
EDL Demo:	ESA

2018 NASA-led mission

Launcher:	NASA – Atlas V 541
Cruise & EDL:	NASA
Rover:	Joint, ESA-NASA



JEWG and iJSWG

- The Joint Mars Executive Board (JMEB) has appointed the following two working groups:

  Joint Engineering Working Group (JEWG):
  - Propose an affordable design for the 2018 rover;
  - Identify contributions from each partner to joint rover.

  Interim Joint Science Working Group (iJSWG): To rapidly provide inputs needed by the JEWG
  - Propose a first set of joint science objectives for the 2018 Joint Rover:

    Identify science requirements (must-have) stemming from previous ExoMars and MAX-C missions;

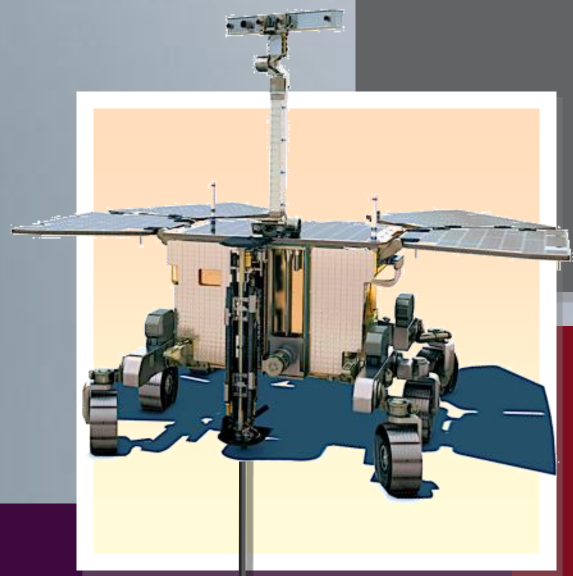
    Identify science opportunities (important/desirable) arising from single rover platform design.
  - Define an envelope for the rover's Reference Surface Mission to estimate nominal mission duration.
  - Composition:

Mark Sephton	Imperial College (UK)
François Raulin	LISA (F)
Abby Allwood	JPL (USA)
Michael Meyer	NASA (USA)
Mitch Schulte	NASA (USA)
Dave Beaty	JPL (USA)
Jorge Vago	ESA (EU)

With contributions from: Sharon Laubach and Charles Whetsel (JPL), Damien Loizeau and Pietro Baglioni (ESA).

- A full fledged JSWG will be formed shortly with the goals to further develop:
  - Mission requirements to allow implementing science objectives;
  - Strawman payload: Incorporate Pasteur payload + identify new instruments capabilities;
  - Rover Reference Surface Mission Scenario.

Previous 2018 Objectives



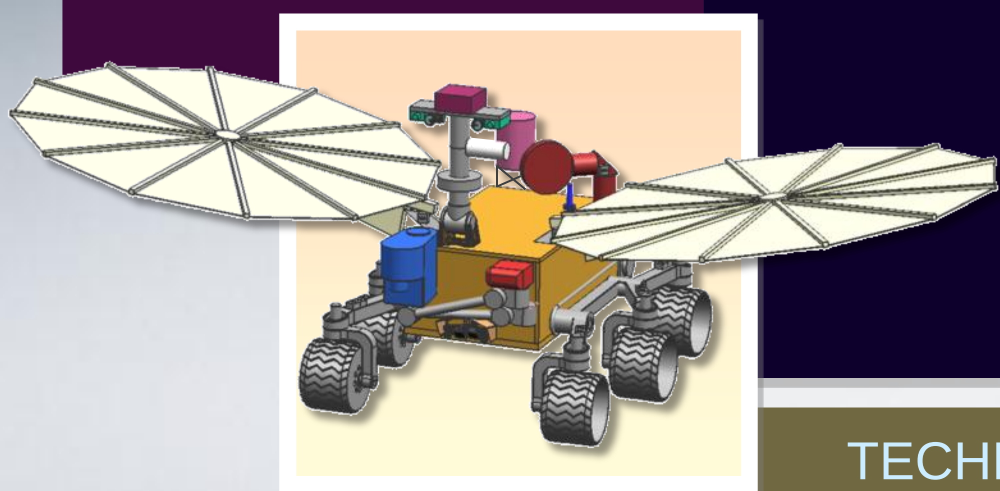
TECHNOLOGY OBJECTIVES

- 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.

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.

2018



SCIENTIFIC OBJECTIVES

- To identify, document, acquire, and cache samples in a manner suitable for collection by a future Mars Sample Return Mission;
- To investigate geological sequences of a few km extent, documenting geological and geochemical variations at various scales.

TECHNOLOGY OBJECTIVES

- Sample coring, acquisition, and encapsulation

2018 (merged) Objectives

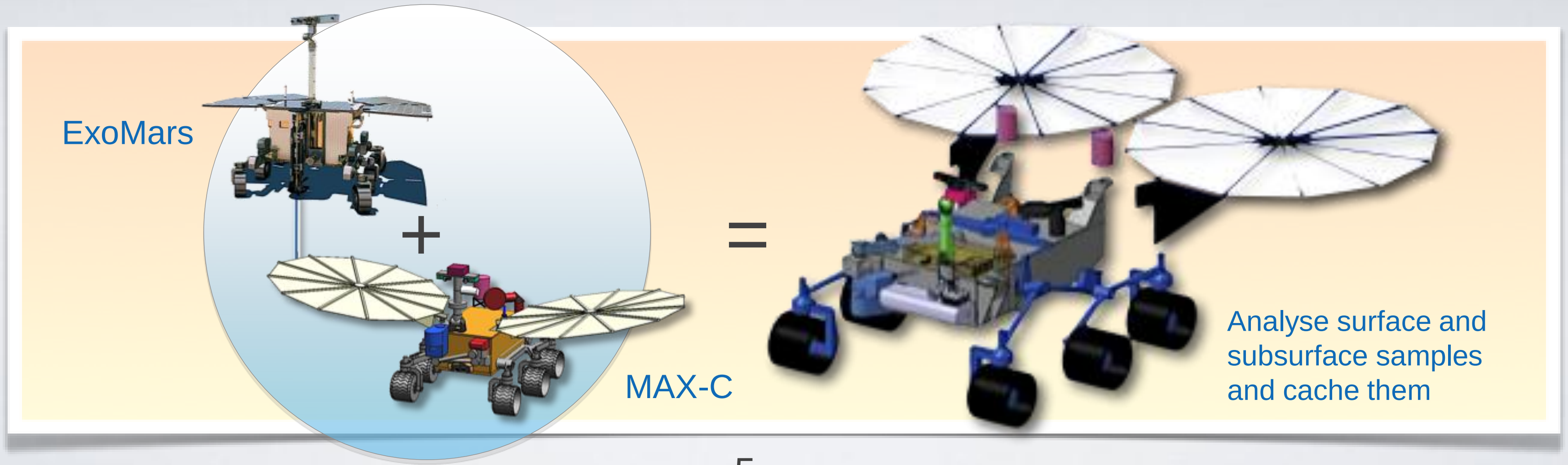
2018

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 determine the landing site's geological context, investigating geological and geochemical variations at various scales.
- To identify, document, acquire, and cache samples in a manner suitable for collection by a future Mars Sample Return Mission.

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;
- Sample encapsulation.



Objectives

The iJSWG has identified the following mission objectives for the 2018 Joint Rover:

A. Landing Site Access

The rover shall land on, or be able to reach, a location possessing high exobiology interest for past life signatures;

B. In-Situ Investigations

The rover shall be able to conduct an integral set of measurements at multiple scales:

1. Geology

The rover shall be able to analyse the landing site's geology;

2. Exobiology

The rover shall search for surface and subsurface organic molecules and physical and chemical biomarkers;

C. Sample Acquisition and Encapsulation

The rover shall have the ability to collect surface rock cores and granular material, such as regolith, and move them into a sample cache;

D. Surface Mission

The mission duration, operations approach, rover, ground and orbital capabilities shall allow pursuing the missions *in-situ* and caching functions.

Objectives Expanded

A. Landing Site Access

The rover shall land on, or be able to reach, a location possessing high exobiology interest for past life signatures; i.e. gain access to an appropriate geological environment for the preservation of potential ancient biomarkers.

The landing site shall include multiple targets enabling the *in-situ* characterization of surface and subsurface geology and exobiology, and the preparation of a cache of carefully selected, diverse samples from well documented environments for return to Earth.

B. In-Situ Investigations

The rover shall be able to conduct an integral set of measurements at multiple scales: beginning with a panoramic assessment of the geological environment, progressing to smaller-scale investigations on surface outcrops and soils, and culminating with the collection of well-selected surface and subsurface samples.

1. Geology

The rover shall be able to analyse the landing site's geology to provide sufficient information for the science team to document the geological context, to achieve the *in-situ* scientific objectives, and to select the materials to cache in support of returned sample science.

2. Exobiology

The rover shall search for surface and subsurface organic molecules and physical and chemical biomarkers. The rover shall test the hypothesis that organics are better preserved at depth. The Rover shall have the ability to acquire samples from the subsurface, down to 2-m depth, and deliver these samples to its Analytical Laboratory Drawer (ALD) for processing and scientific analysis.

C. Sample Acquisition and Encapsulation

The rover shall have the ability to collect surface rock cores and granular material, such as regolith, and move them into a sample cache. The collected material shall be appropriately encapsulated and sealed for long-term storage on the surface of Mars, and for transport back to the Earth at a later date.

D. Surface Mission

The mission duration, operations approach, rover, ground and orbital capabilities shall allow pursuing the missions *in-situ* and caching functions needed to achieve the science objectives.

Requirements

The iJSWG has identified the following mission requirements for the 2018 Joint ExoMars-C Rover:

Requirements: Are mandatory.

Opportunities: Important/desirable additional science capabilities – not mandatory.

Implementation of opportunities depends on importance and availability of resources —to be decided by JMEB.
Not all opportunities have the same importance.

Landing:

Requirements:
- MSL-like in terms of altitude and hazards negotiation;
- Latitude: –15° to +25° (ExoMars was –5 to +25);

Opportunities:
- Add hazard avoidance capability to increase choice of landing sites (very important);
- Extend landing site latitude to –25° or more (less important).

Instruments:

Requirements:
- Fly the entire Pasteur payload;
- Fly robotic arm with corer + RAT;
- Fly caching system;
- Add mineralogy instrument to mast (e.g. IR spectrometer);
- Contact instruments on robotic arm to include:
  Close-up imager (like CLUPI), mineralogy (e.g. ext. Raman), elemental analysis (e.g. Mössbauer or APXS).

Opportunities:
- Carbon identification instrument on robotic arm (less important);
- Ability to cache subsurface drill samples (very important);
- Ability to pass robotic arm samples to Analytical Laboratory Drawer (less important).

Mission lifetime:

Requirements:
- Nominal mission: 1 Mars year (680–700 sols).

Note: Constructing a credible reference mission scenario in line with science objectives may preclude long traverses associated with "go-to" landing sites.

Science Exploration Scenario

Determine the rover's geological context:

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

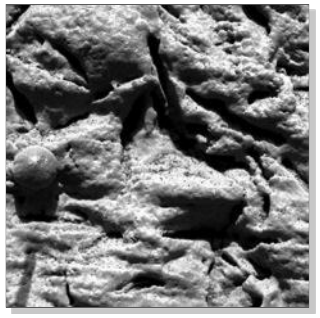
Collect a subsurface (or surface) sample

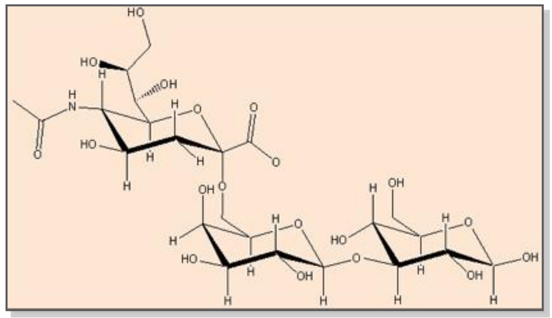
Study sample:

- Survey analysis
- Detailed analysis

Analytical Laboratory

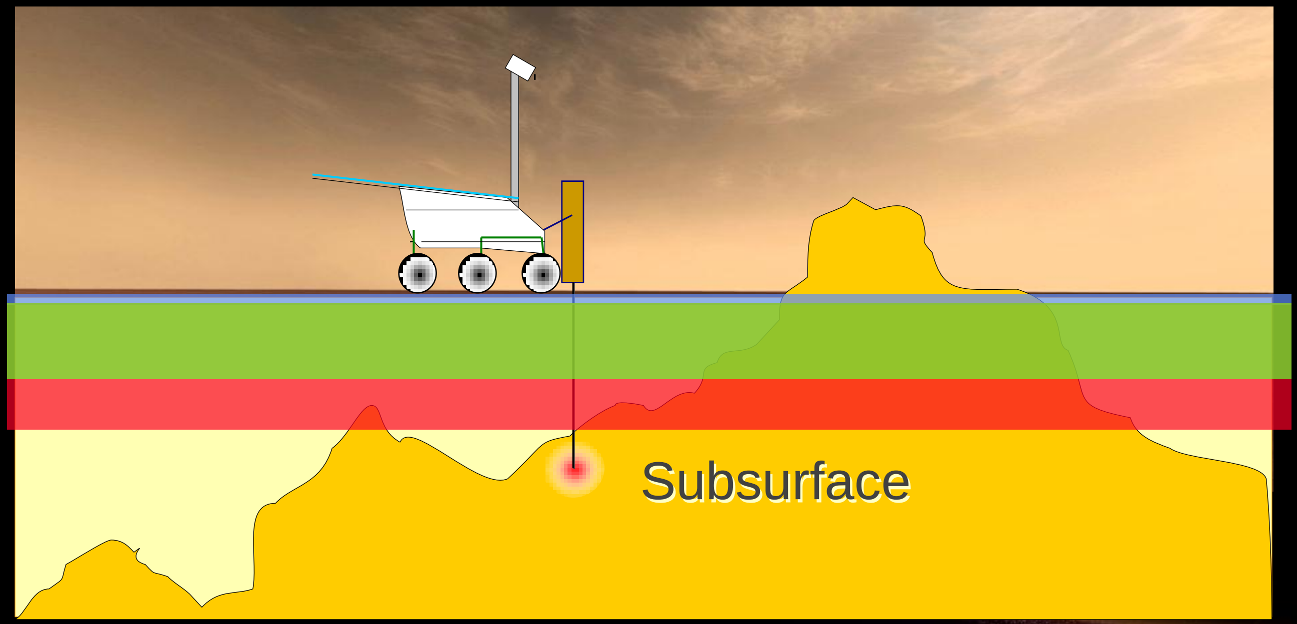
Cache Sample





Scale

Where to Search



Penetration of organic destructive agents

UV Radiation	~ 1 mm
Oxidants	~ 1 m
Ionising Radiation	~ 1.5 m

ExoMars exobiology strategy:

Identify and document the appropriate type of outcrop;

Collect samples below the degradation horizon and analyze them.

Robotic Arm

a) Includes a Rock Abrasion Tool (RAT) and a corer capable to collect rock core and granular material samples;

b) Accommodates contact instruments for studying outcrops and soils:

Required: Imaging, mineralogy, and elemental analysis (e.g. CLUPI, External Raman, Mössbauer);

Opportunity: Instrument to identify carbon presence.

c) Robotic arm sampling transfer capabilities:

Required: Be able to transfer collected samples to the caching system;

Opportunity: Be capable to receive samples from the subsurface drill and pass them on to the caching system (very important);

Be able to transfer samples to the Analytical Laboratory Drawer (less important).

Pasteur Selected Payload

Instrument Name	Description	Countries
PanCam (WAC + HRC)	Panoramic camera system	**UK**, D, CH H/W F, I, A, USA Sci
WISDOM	Shallow ground-penetrating radar	**F**, D N, USA, B, I, E, UK
CLUPI on drill box	Close-Up Imager	**CH**, F CAN, UK, D, I, B
Ma_MISS included in 2.0-m drill	IR borehole spectrometer	**I** P, PL
MicrOmega	IR imaging spectrometer	**F** CH, RUS, I, D, UK
RLS	Raman spectrometer	**E**, F, UK D, NL, USA
Mars-XRD	X-ray diffractometer + X-ray fluorescence	**I**, UK E, P, NL, D, F, RUS, USA, AUS
MOMA	LD-MS + Pyr-Dev GC-MS for organic molecule characterisation	**D**, F, USA NL, S
LMC	Life Marker Chip	**UK**, NL, I D, N, USA

Caching System

a) Can receive surface (and subsurface) samples from the robotic arm;

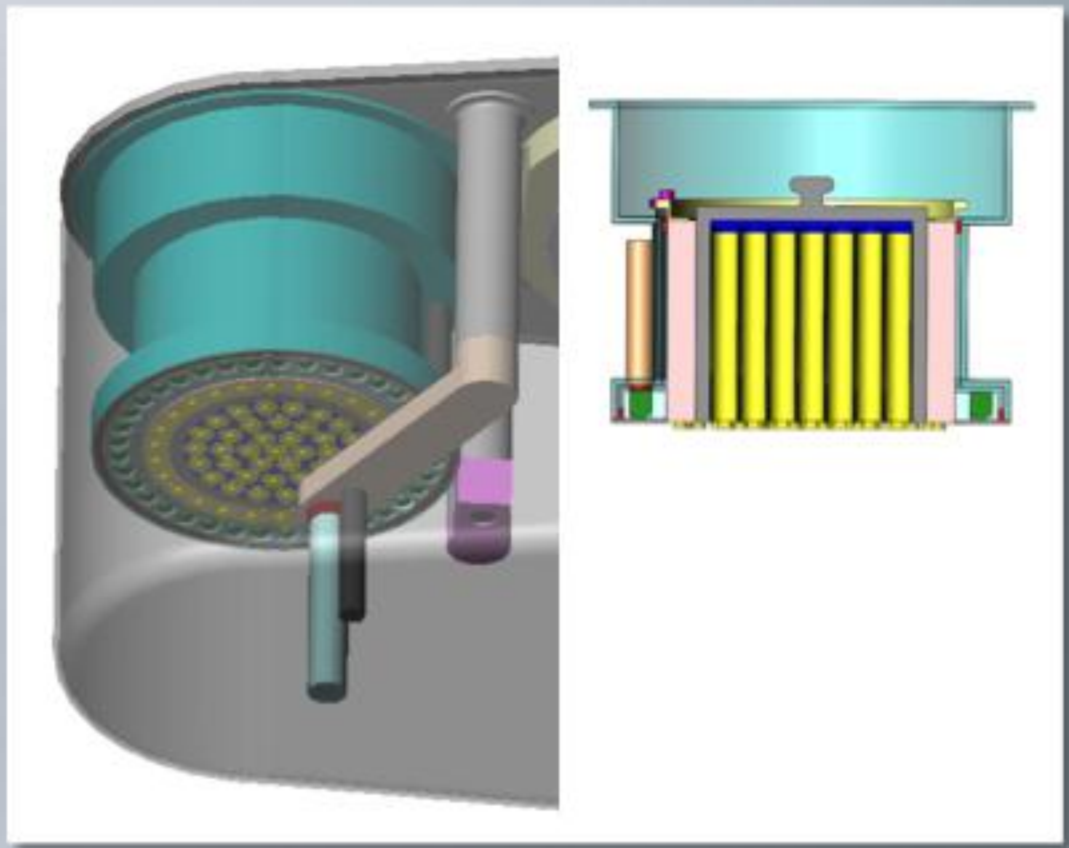
b) Encapsulates samples;

c) Each sample is stored in its own, dedicated container;

d) Protects samples from surface degradation conditions;

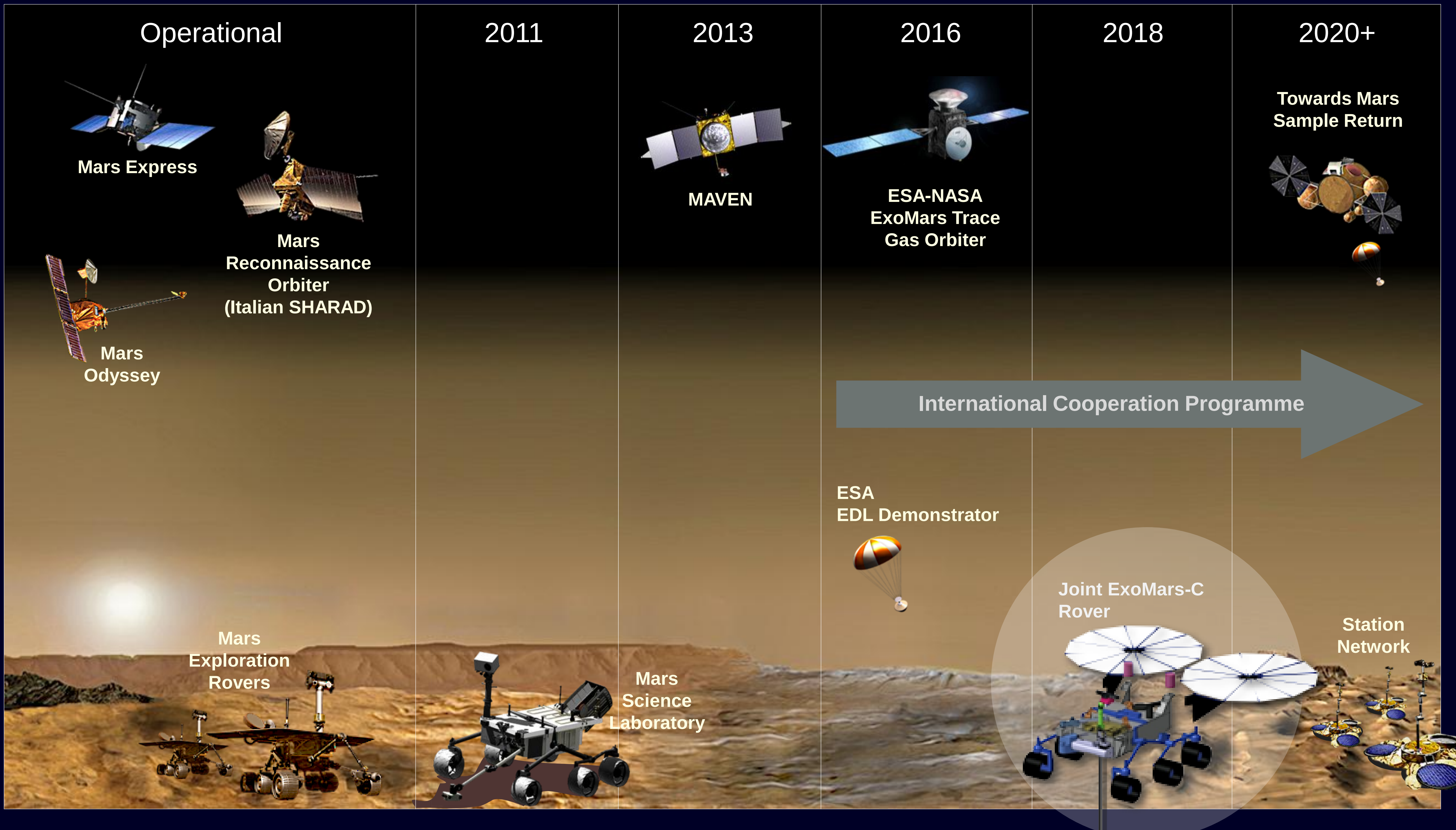
e) Design minimizes sample temperature excursions, but through passive means, i.e. no cooling;

f) Can be deposited on the Martian surface for later retrieval by MSR mission.



New International Context

E X O M A R S - C



- **MSL**: powerful rover; large 2-D mobility.
- **ExoMars-C**: next-generation instruments; 3-D access; sample caching.

Following on the results of MSL, ExoMars-C is the logical next step in international Mars surface exploration.