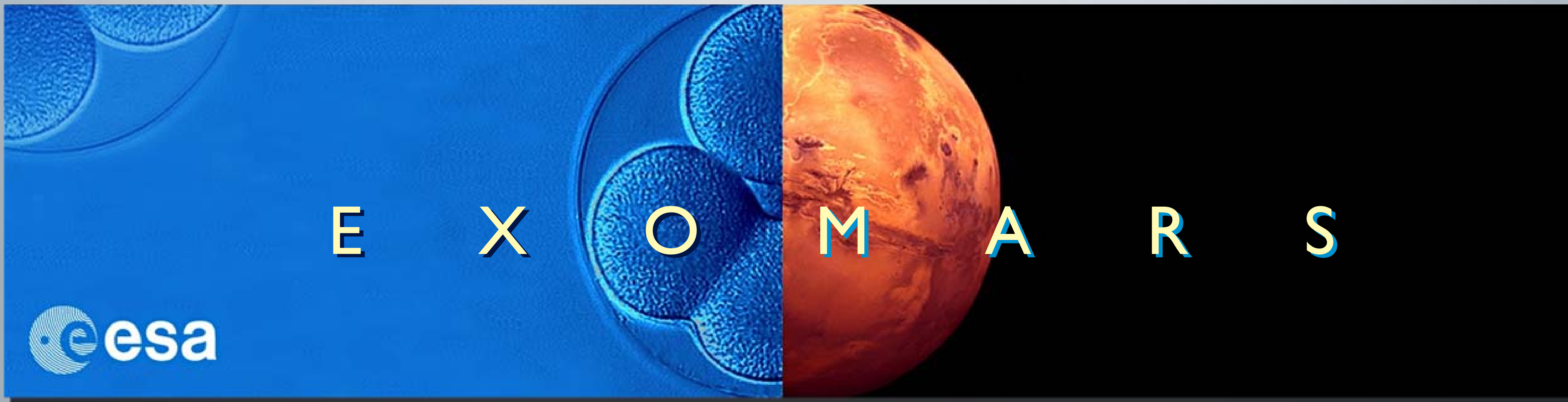
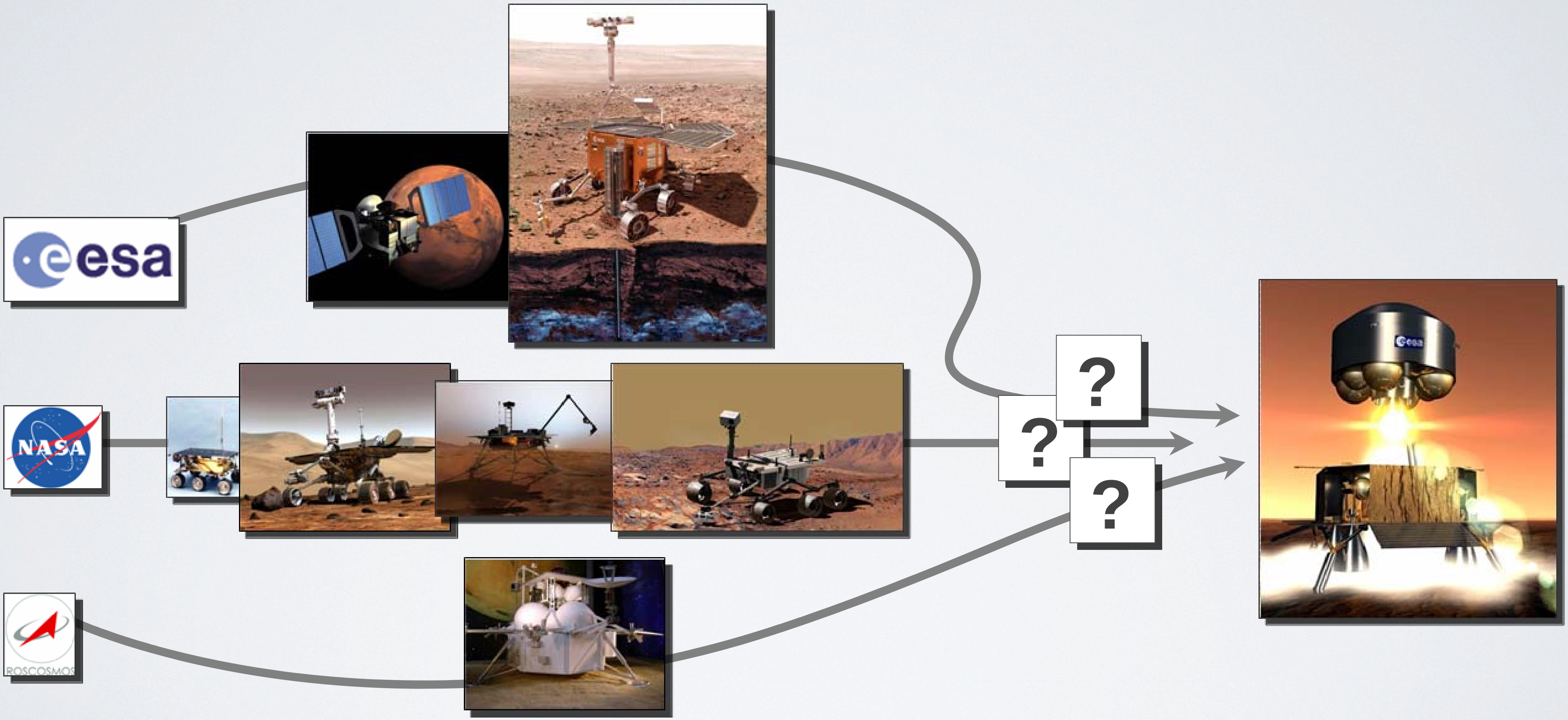


The ESA/NASA ExoMars Programme

International Scene

- Recognising that a Mars Sample Return (MSR) mission is very challenging, and that its and that its undertaking will likely exceed the financial capabilities of any one agency, one agency,



Programme Building Blocks

E X O M A R S

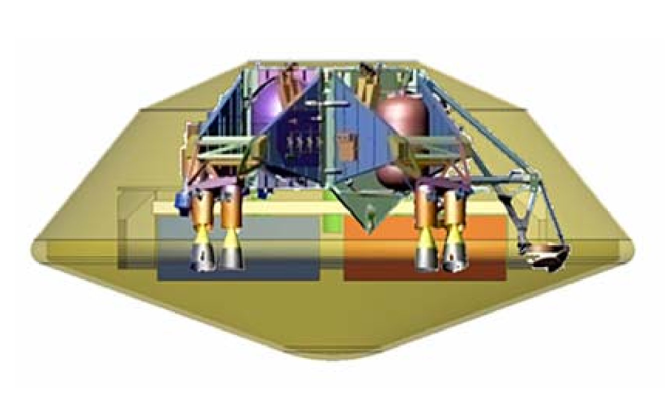
- ESA and NASA have agreed to embark on a joint Mars robotic exploration programme:
  - Initially, seek agreement on mission configurations for 2016, 2018, and 2020 opportunities;
  - ExoMars becomes a key element of the 2016 and 2018 scenario;
  - ExoMars spreads its objectives over two opportunities.

2016 ESA-led mission

Launcher:	NASA – Atlas V 421
Orbiter:	ESA
Payload:	ESA-NASA
Lander:	ESA

2018 NASA-led mission

Launcher:	NASA – Atlas V 531
Cruise & EDL:	NASA
Rover 1:	ESA
Rover 2:	NASA



Mission Objectives

TECHNOLOGY OBJECTIVES

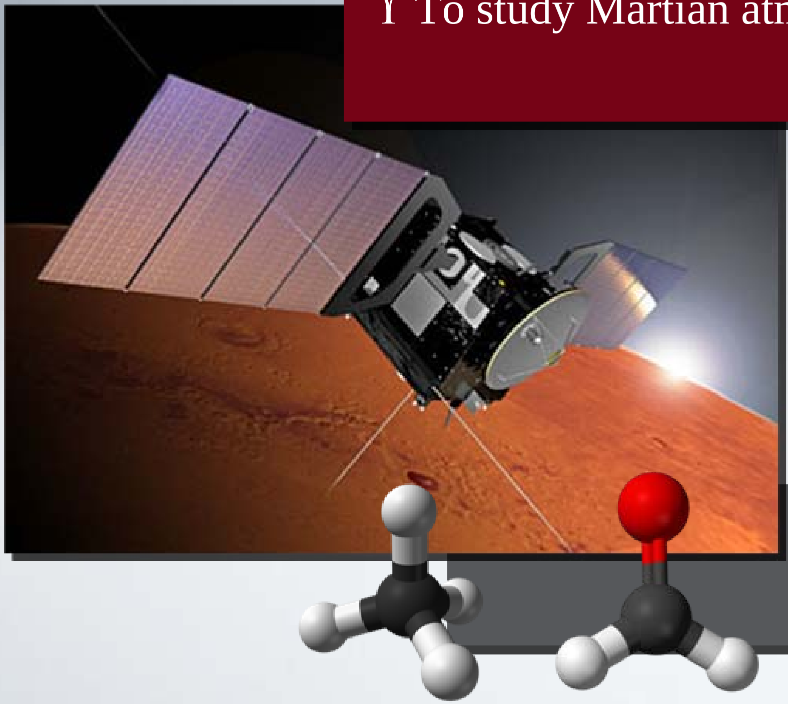
ϒ Provide data relay services to landed missions until 2022;

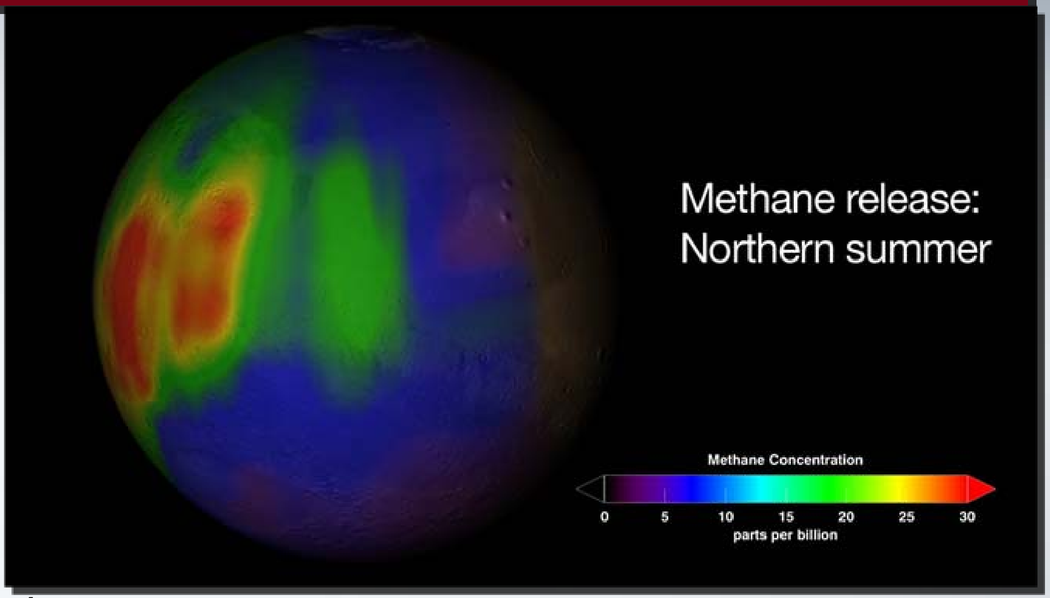
ϒ Entry, Descent, and Landing (EDL) of a payload on the surface of Mars

2016

SCIENTIFIC OBJECTIVE

ϒ To study Martian atmospheric trace gases and their sources.





Orbiter Model Payload

#	Acronym	Description	View Modes	Observation Modes	
1	SFTIR	Solar Fourier Transform IR Spectrometer: **Broad survey** of trace gases with high precision	Solar Occultation only; passive radiative cooler	2 Solar Occultations per orbit (~24/day); processing interferorgrams throughout orbit	
1	SLNIR	Solar-Nadir IR Mapper: Detection and mapping of **specific** trace gases	Solar occultation; nadir and limb viewing; heat sink required (assumed to be provided by s/c)	2 solar occultations + dayside nadir/limb (60 min) on each orbit	
2	Sub-mm	Sub-mm Spectrometer profiler/mapper **Atmospheric temperature & winds** plus **H2O and specific** trace gases	Nadir and limb, including away from velocity vector	Continuous operations switching between nadir, space, different limb; observe both sides of ground track	
2	TIR	Thermal IR profiler/mapper spectrometer or radiometer for atmospheric **temperature and dust**, plus **H2O and some** trace gases	Nadir and limb views, including away from velocity vector	Continuous operations switching between nadir, space, different limb; observe both sides of ground track	
2	WAC	Wide Angle Camera imaging **atmospheric phenomena** for discriminating between surface, dust clouds, & ice clouds	push-frame operation with .GE. 2 color bands; requires alignment with ground track motion	Cross-track (nearly orthogonal to velocity vector) horizon-to-horizon	
3	HRCSC	High Resolution Color Stereo Camera: **Surface imaging**	~1 m/pixel ground sampling (at nadir) with TDI; fore/nadir/aft views	Designated targets of opportunity; requires alignment with ground track motion (mitigation needed)	

Mission Objectives

E X O M A R S

2018

TECHNOLOGY OBJECTIVES

ϒSurface mobility with a rover (having several kilometres range);

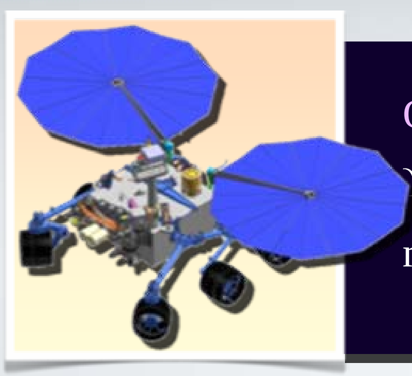
ϒAccess to the subsurface to acquire samples (with a drill, down to 2-m depth);

ϒSample acquisition, preparation, distribution, and analysis.

SCIENTIFIC OBJECTIVES

ϒTo search for signs of past and present life on Mars;

ϒTo characterise the water/subsurface environment as a function of depth in the shallow in the shallow subsurface.



OBJECTIVE

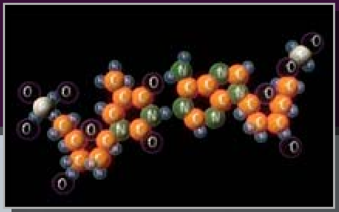
ϒTo identify, acquire, document, and cache “outstanding” samples in a manner suitable manner suitable for collection by a future Mars Sample Return mission.

What to Search For

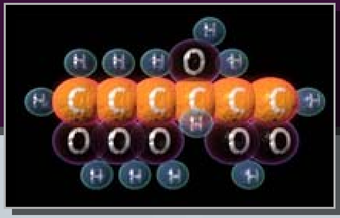
EXOMARS

- **PRESENT LIFE:** Biological markers, such as:

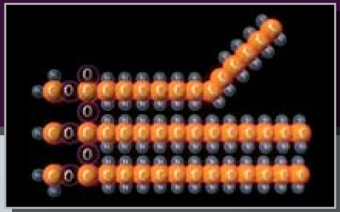
Amino acids



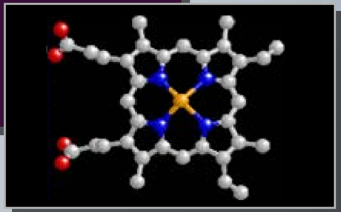
Nucleobases



Sugars



Phospholipids



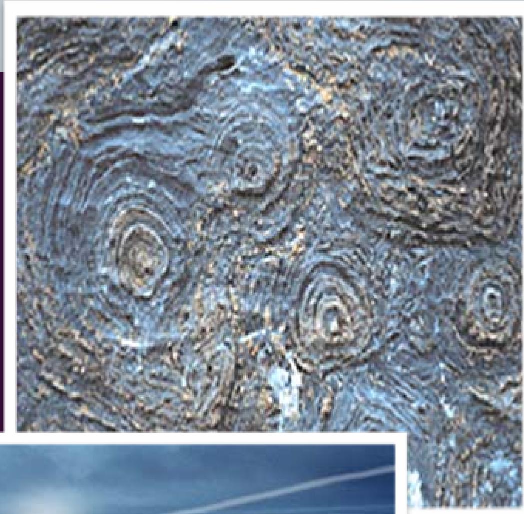
Pigments

...

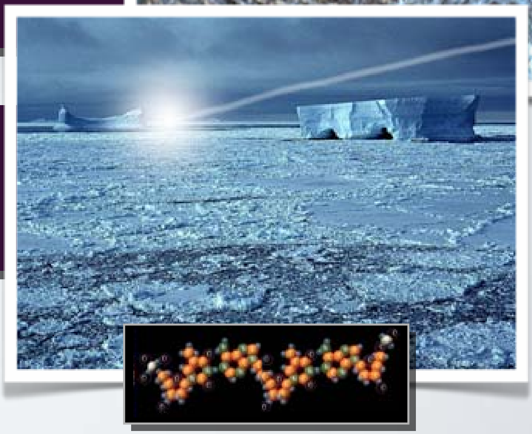
- **PAST LIFE:** Organic residues of biological origin; (chemical, chiral, spectroscopic, and isotopic info)

  Images of fossil organisms and their structures;

  (morphological evidence)



- **DELIVERED ORGANICS:** by meteoritic and cometary infall



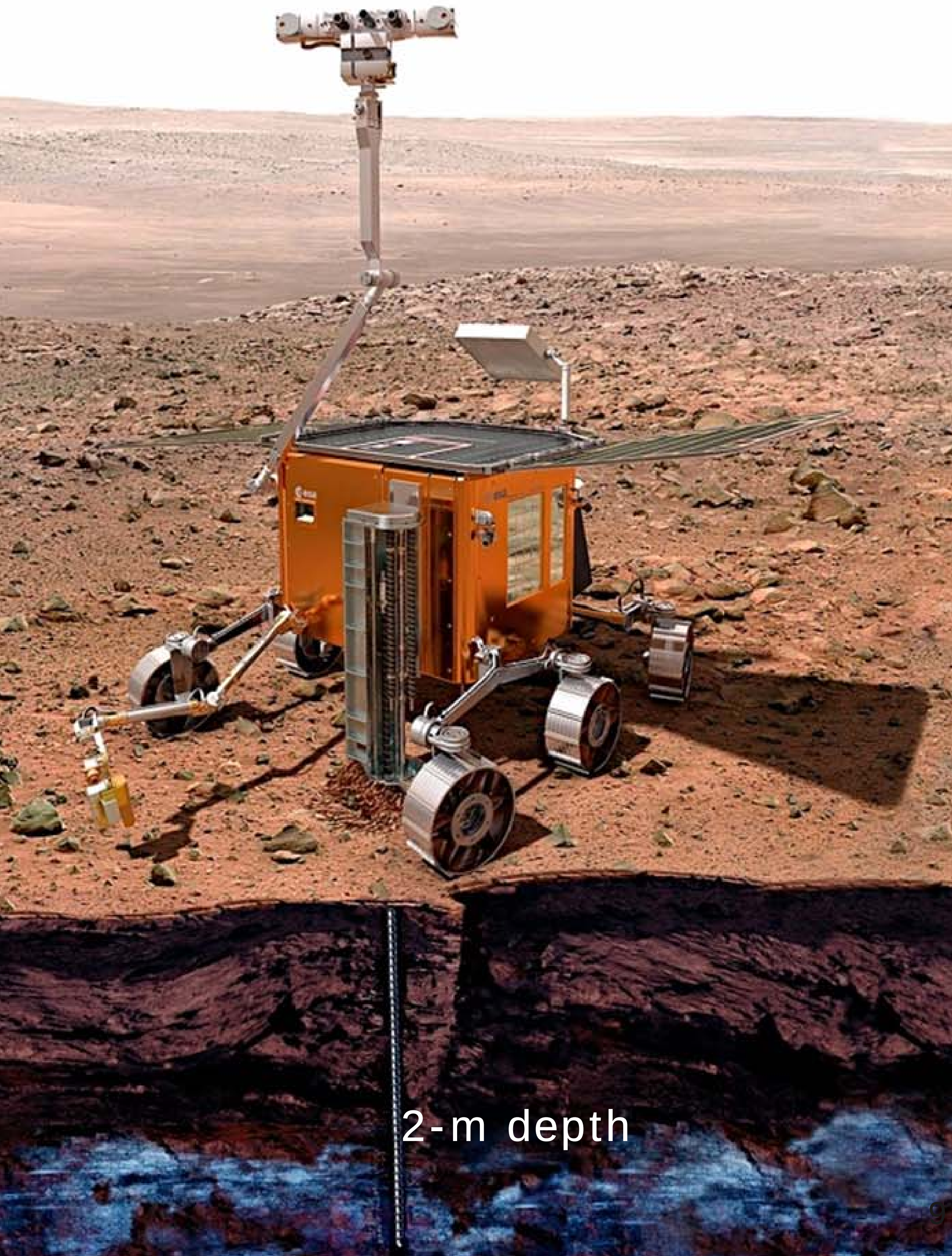
The EDLS Demonstrator

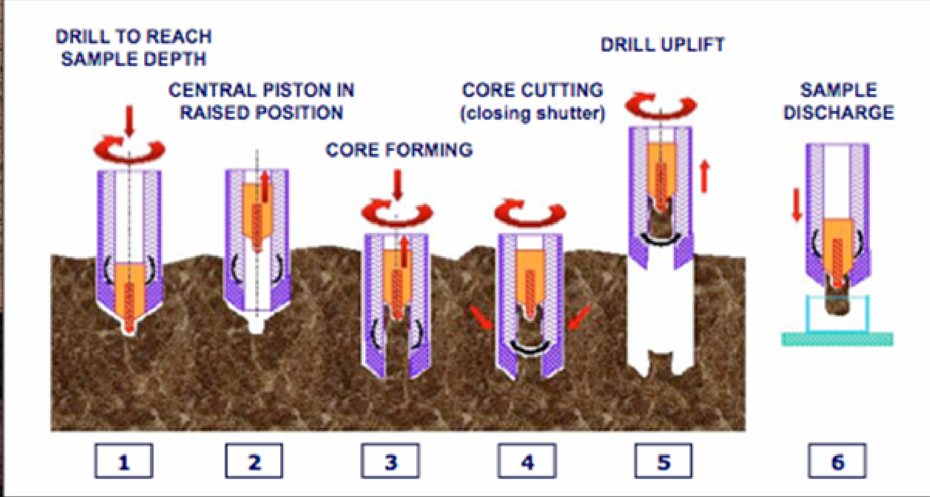
E X O M A R S

- **Maximum Mass at launch 600Kg**
- **Semi-soft (almost soft) lander with liquid retro-propulsion**
- **Landing gears (TBD) crushable material, vented airbabags, legs**
- **Minimum Payload operated on primary battery (5-7 sol lifetime)**
- **Mass less than 5Kg and no deployment mechanisms**
- **Science Goals: mostly environmental assessment**

ExoMars Rover

Nominal mission:	180 sols
Nominal science:	6 Experiment Cycles + 2 Vertical Surveys
EC length:	16 – 18 sols
Rover mass:	300 kg
Mobility range:	Several km





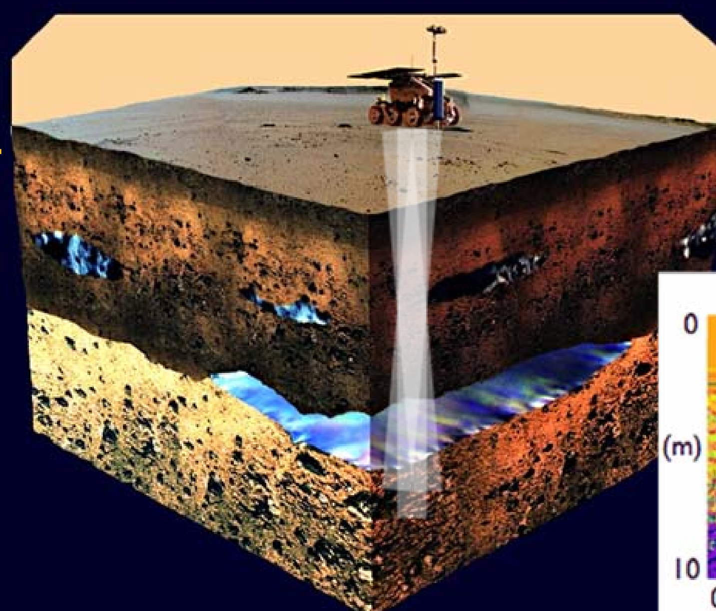
esa

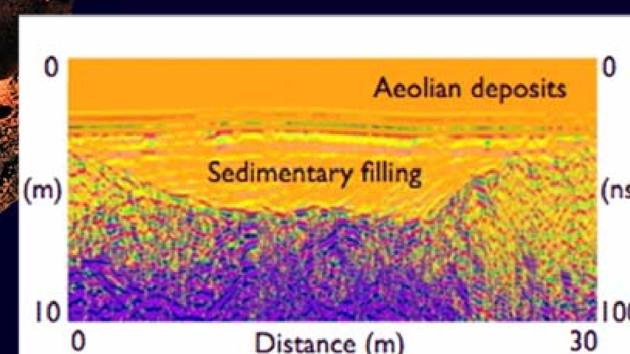
Site Characterisation

EXOMARS

AT PANORAMIC SCALE: To establish the geological context

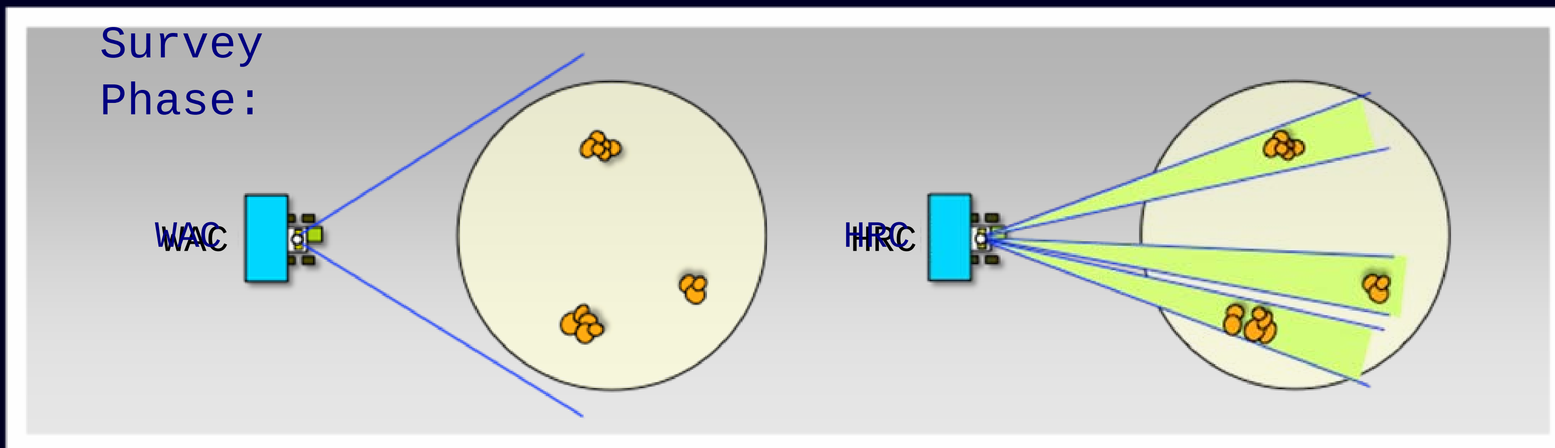
Ground Penetrating Radar

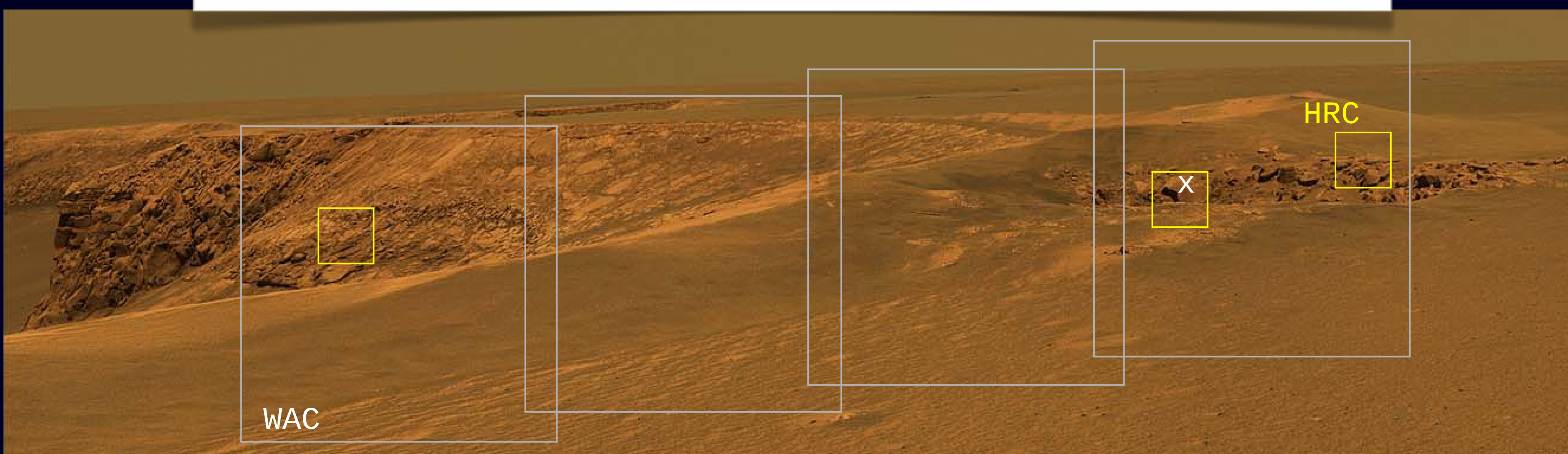




Heggy et al. 2007

AT PANORAMIC SCALE: To establish the geological context





Outcrop Characterisation

E X O M A R S

AT ROCK SCALE: To ascertain the past presence of water

For a more detailed morphological examination

High-Resolution Camera

Close-Up Imager

Next step: **ANALYSIS**

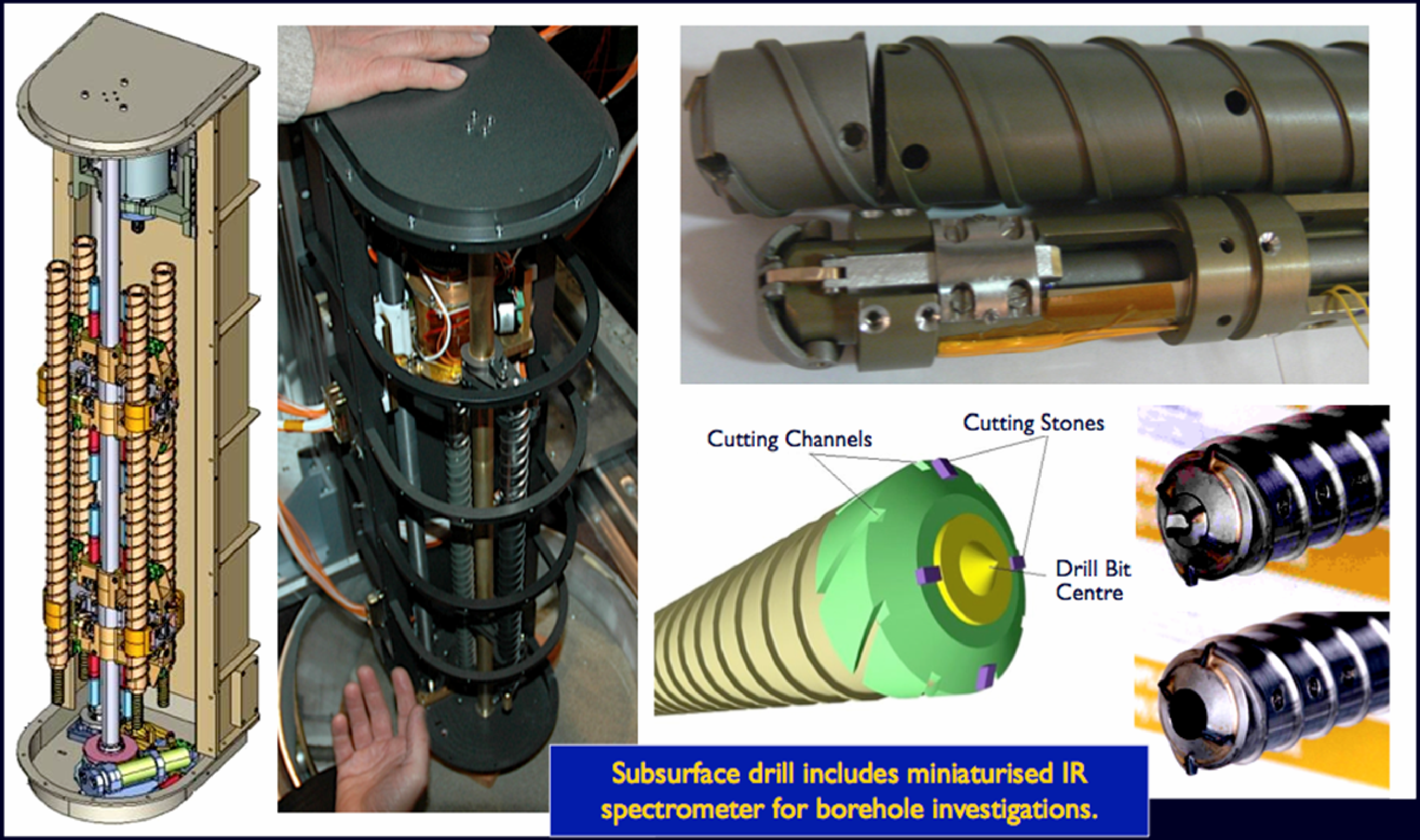
Use the drill to collect a sample

- From an outcrop
- From the subsurface

Subsurface Drill

E X O M A R S

OBTAIN SAMPLES FOR ANALYSIS: From 0 down to 2-m depth

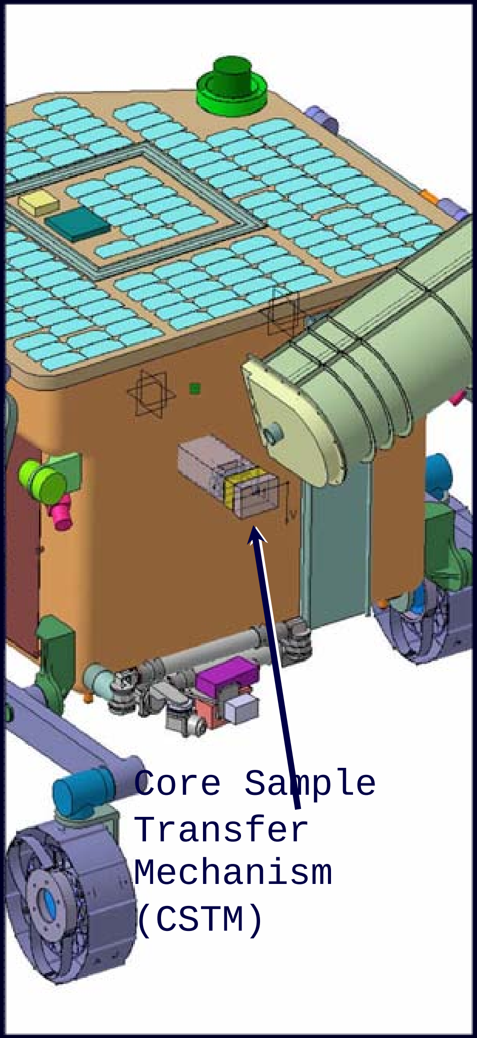


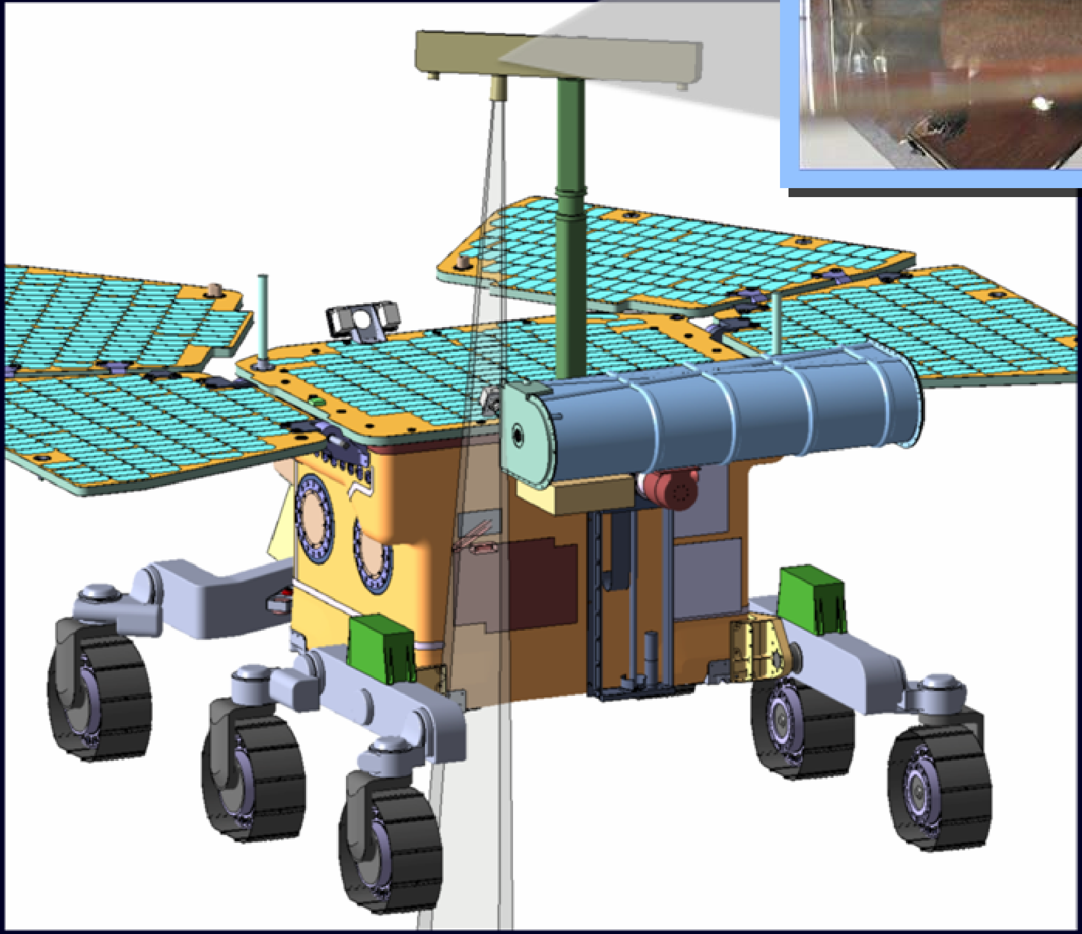
Subsurface drill includes miniaturised IR spectrometer for borehole investigations.

Sample Delivery

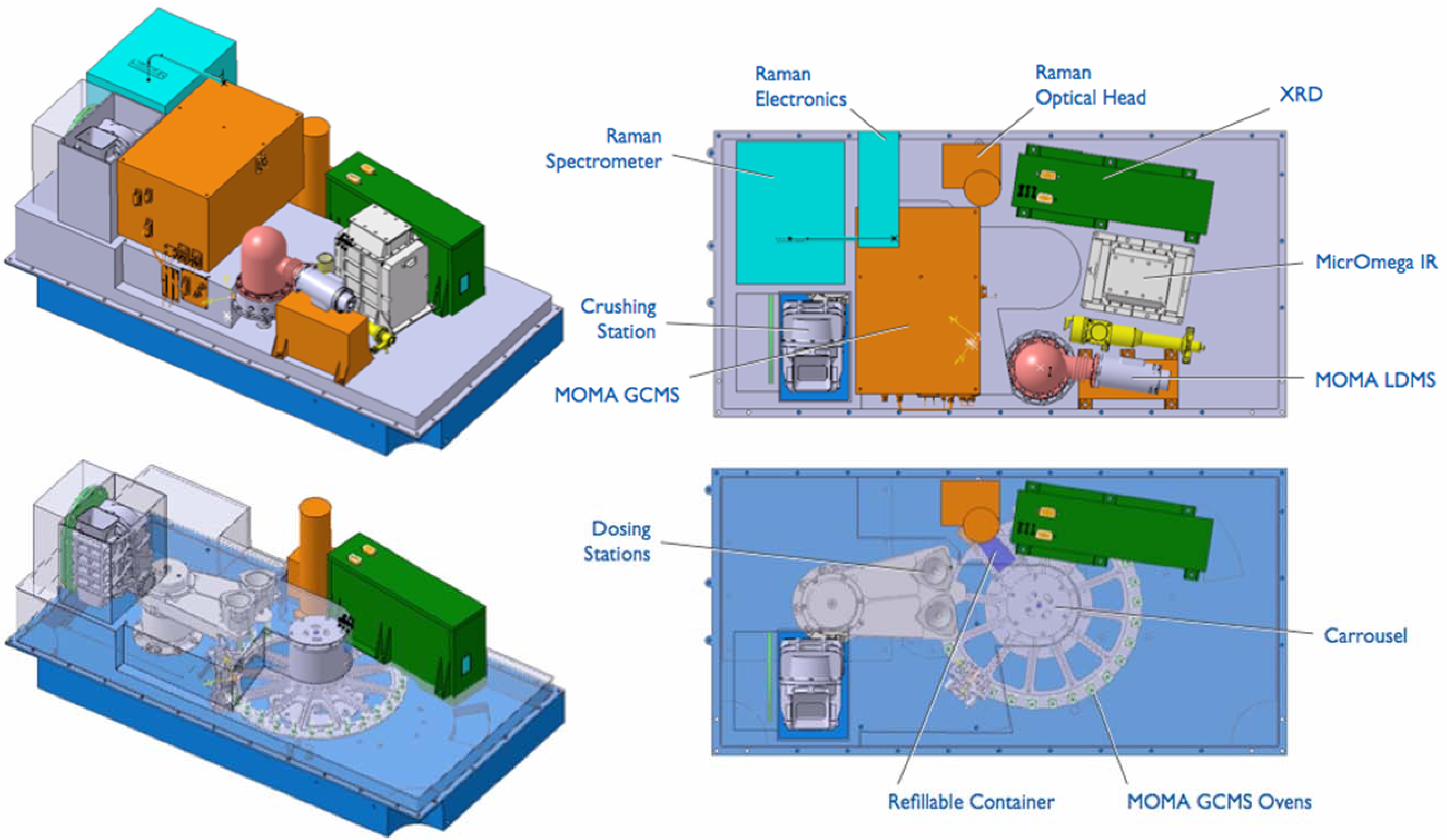
DRILL discharges sample into Core Sample Transport Mechanism (CTSM).

PanCam **HRC** images sample.



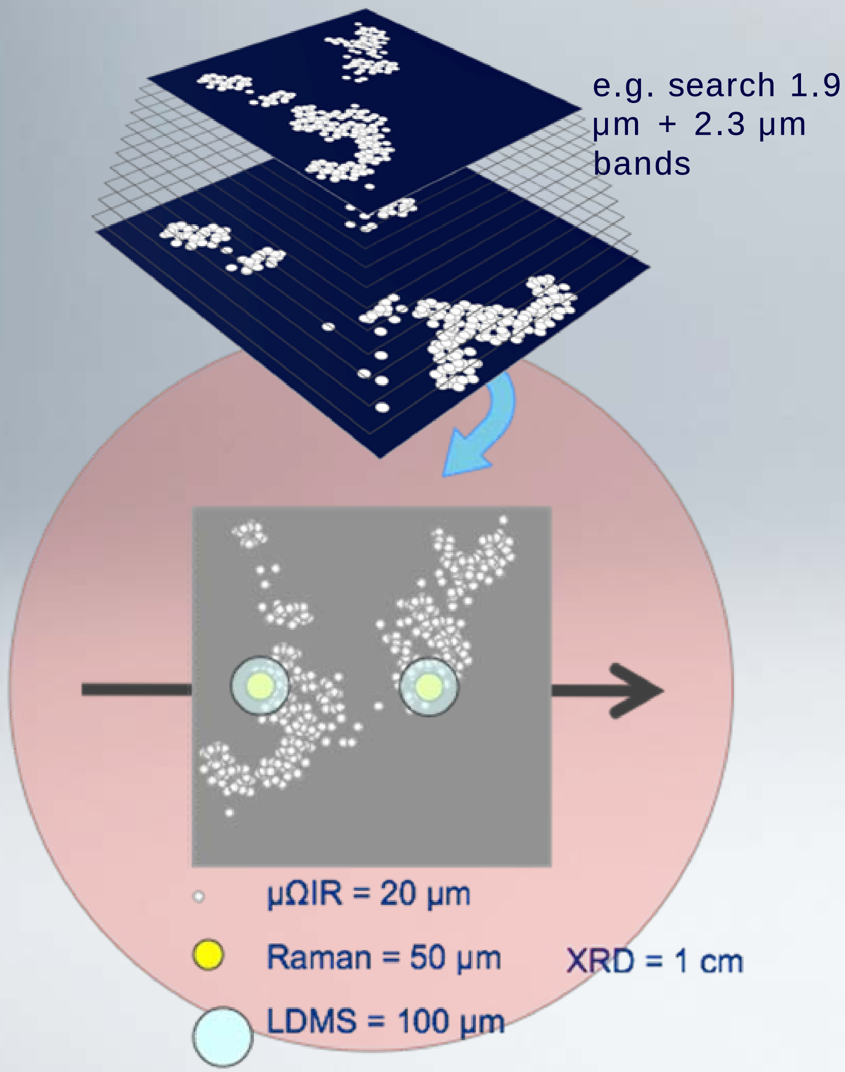


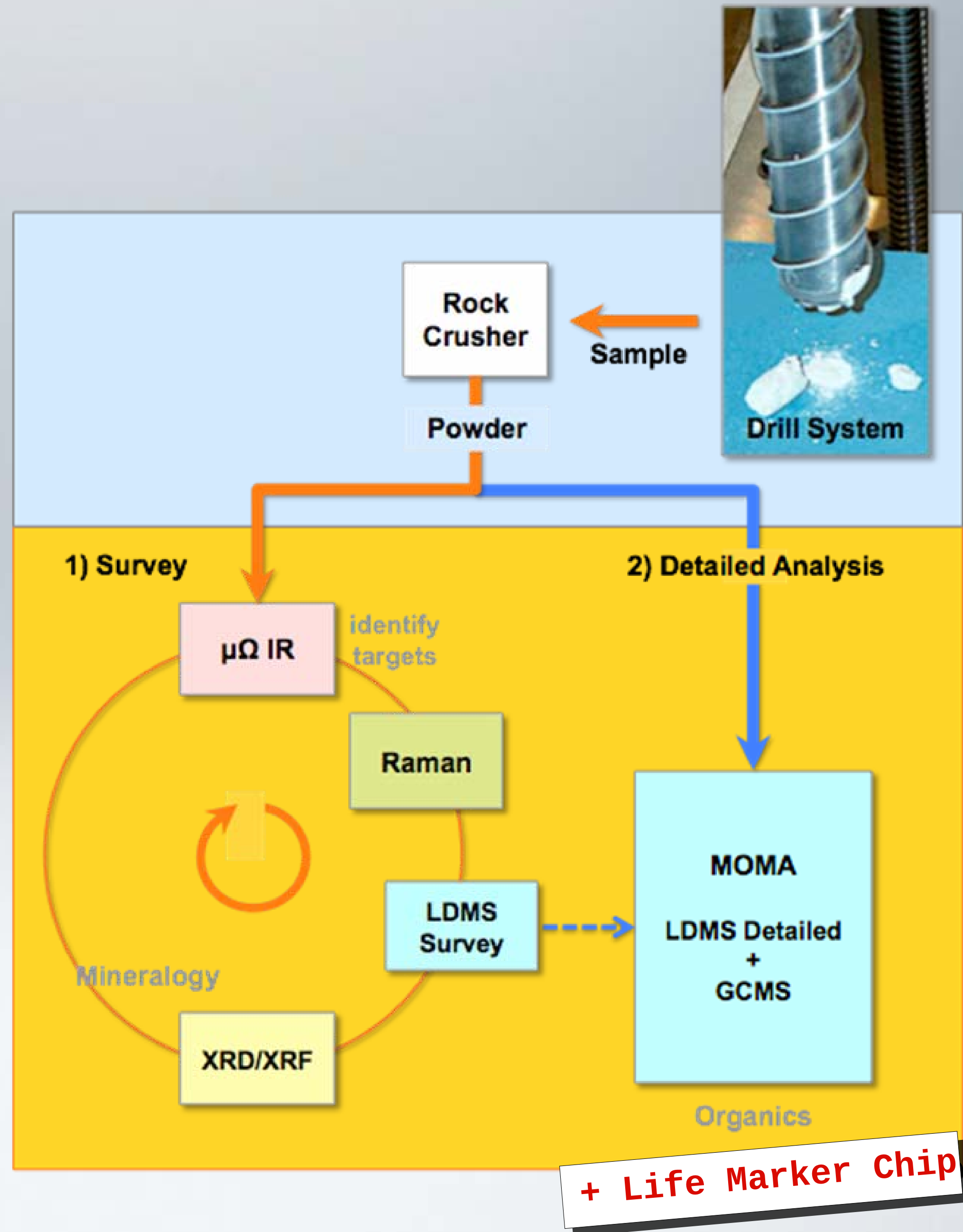
Analytical Laboratory



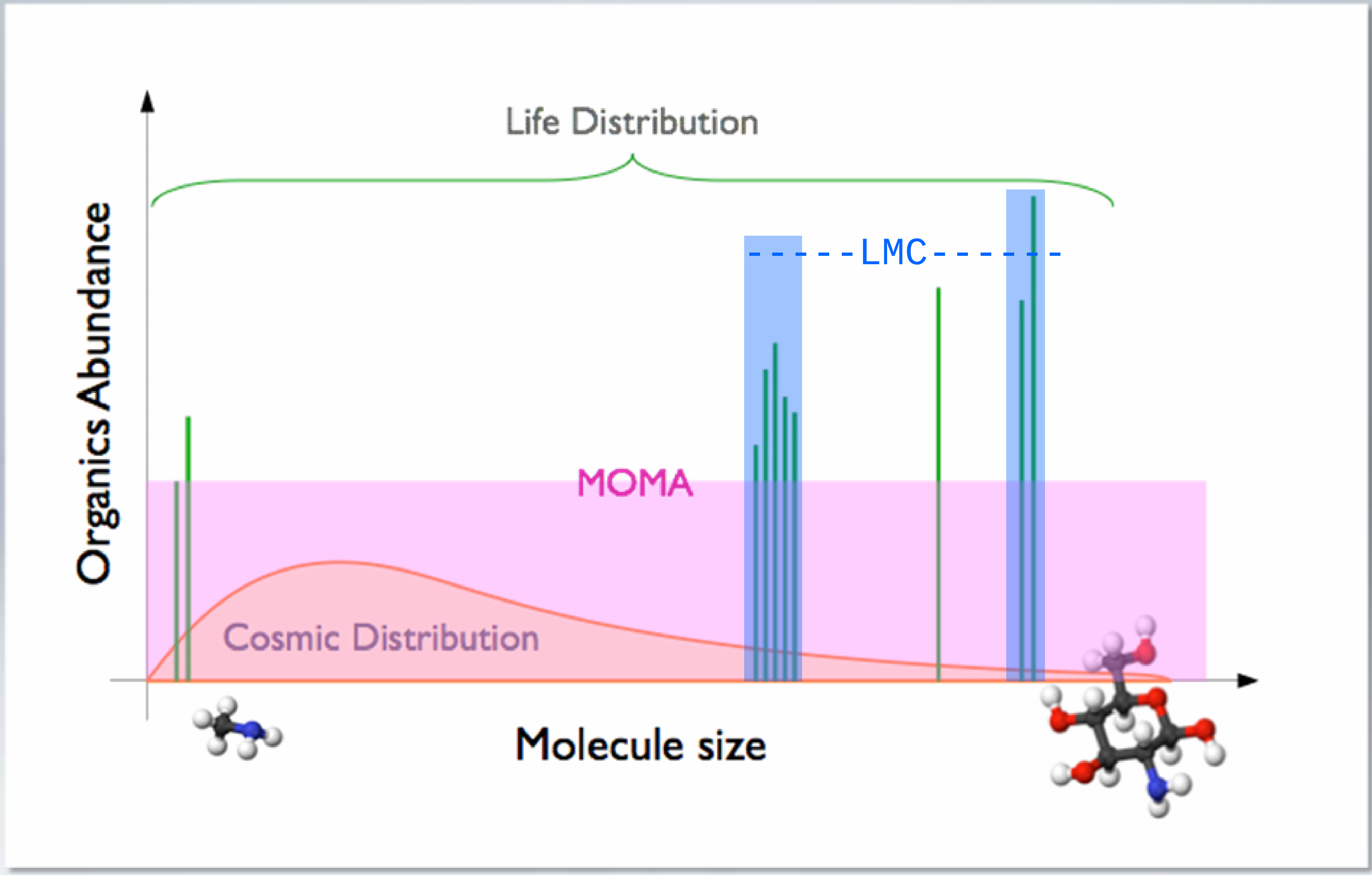
Sample Analysis

Use mineralogical + image information from µΩIR to identify targets for Raman and MOMA-LDMS.





Sample Analysis



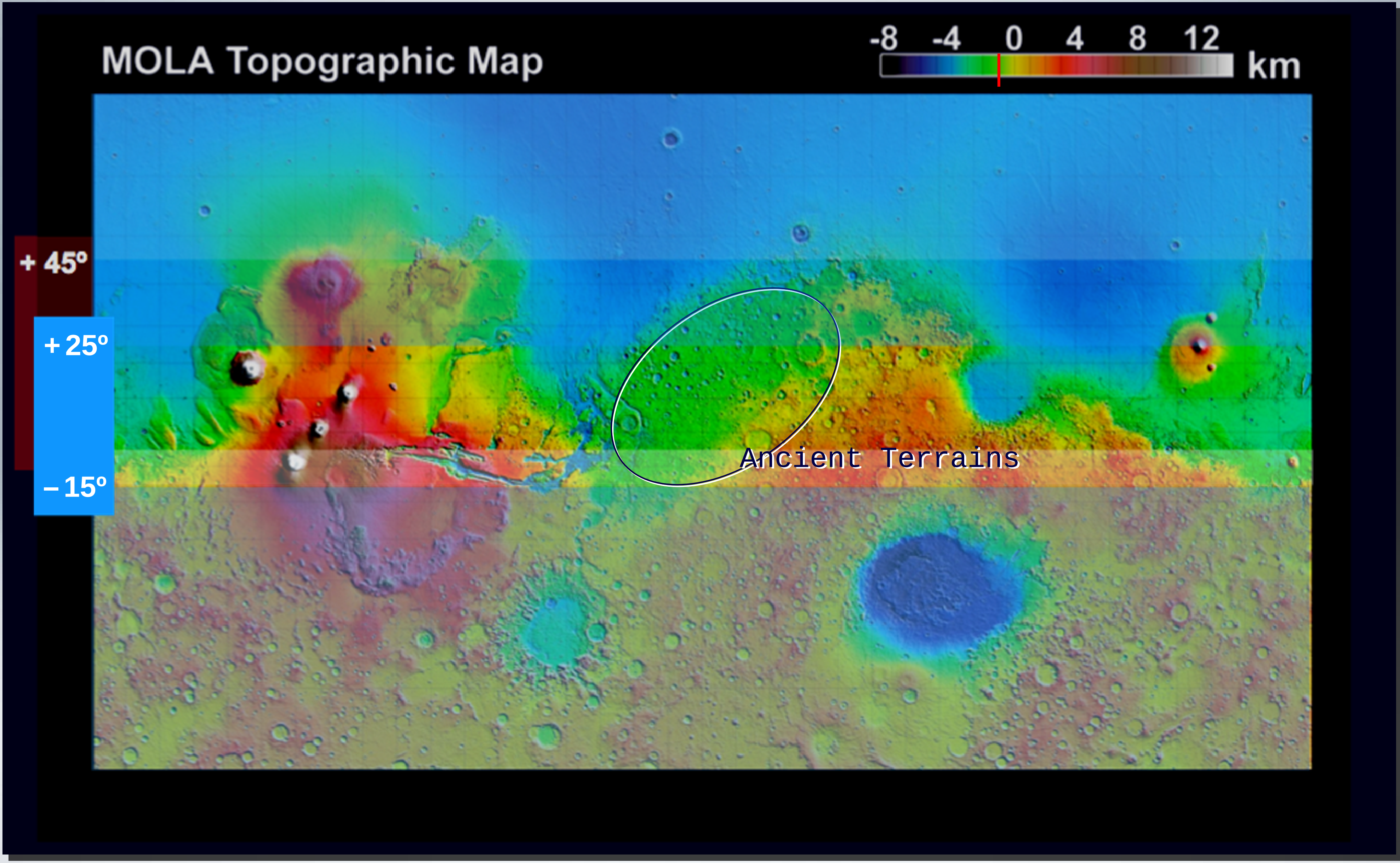
Approved Pasteur Payload

Instrument Name	Description	Mass (kg) including maturity margin
PanCam (WAC + HRC)	Panoramic camera system	1.560
MOMA	LD-MS + Pyr GC-MS for organic molecule characterisation	6.100
MicrOmega IR	IR imaging spectrometer	0.960
Mars-XRD	X-ray diffractometer + X-ray fluorescence	1.480
Raman (internal)	Raman spectrometer	2.260
WISDOM	Shallow ground-penetrating radar	1.380
Ma_Miss included in 2.0-m drill	IR borehole spectrometer	[illegible]

+ CLUPI
+ Life Marker Chip

Landing Latitudes

E X O M A R S



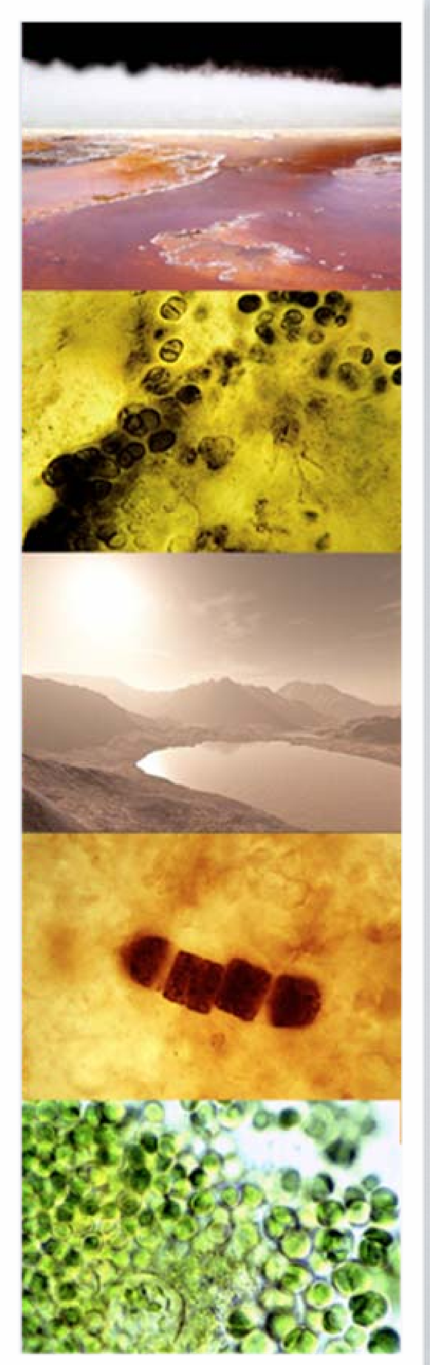
Sites' Scientific Interest

ExoMars is a powerful exobiology mission:

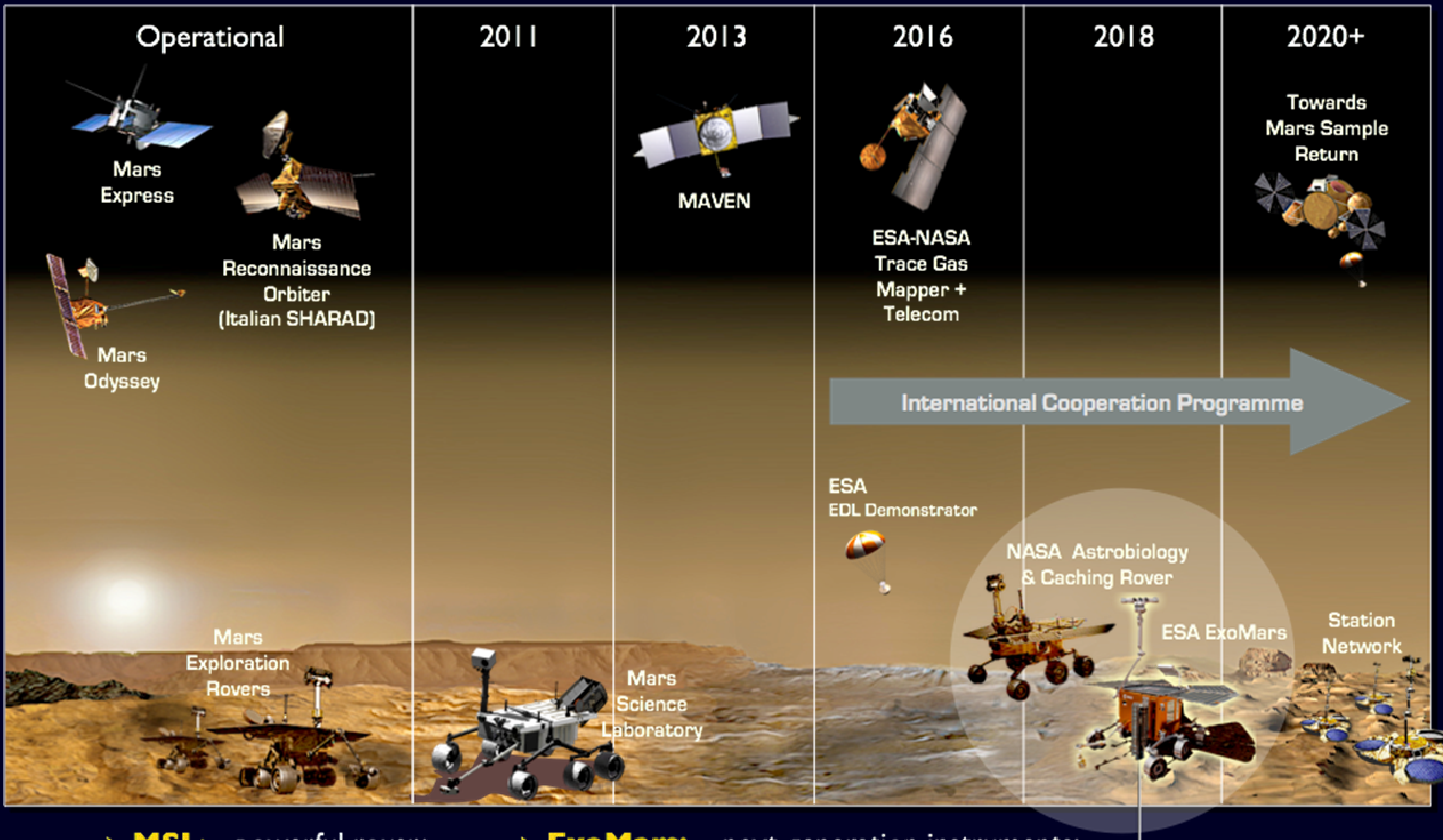
We will search for signs of life...
in places where nobody has looked,
with instruments that no one has yet flown.

- The proposed landing sites must cater to this overarching scientific goal. scientific goal.
- Proposed landing sites must contain evidence strongly suggestive of a past or of a past or present habitable environment.
- The prevailing outcrop mineralogy must be favourable for the long-term long-term preservation of organic molecules.
- Recently exhumed locations are particularly attractive —because of the long-of the long-term radiation shielding provided while they were buried. buried.
- Proposed sites must include several attractive targets within the ellipse. ellipse.
- Proposed sites must maximise opportunities for useful subsurface science science investigations.

... and be safe for landing.



International Scenario



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

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