The ExoMars Programme

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NASA PPS
12–13 November 2013, GSFC
(USA)

Cooperation

ExoMars Programme

- Consists of two missions, in 2016 and 2018.
- A cooperation between ESA and Roscosmos (agreement signed in Mar 2013).
- The programme includes some important contributions from NASA.
- ExoMars constitutes ESA's highest priority in robotic exploration.

Credit: MEX/HRSC

2016 Mission Objectives

EXOMARS

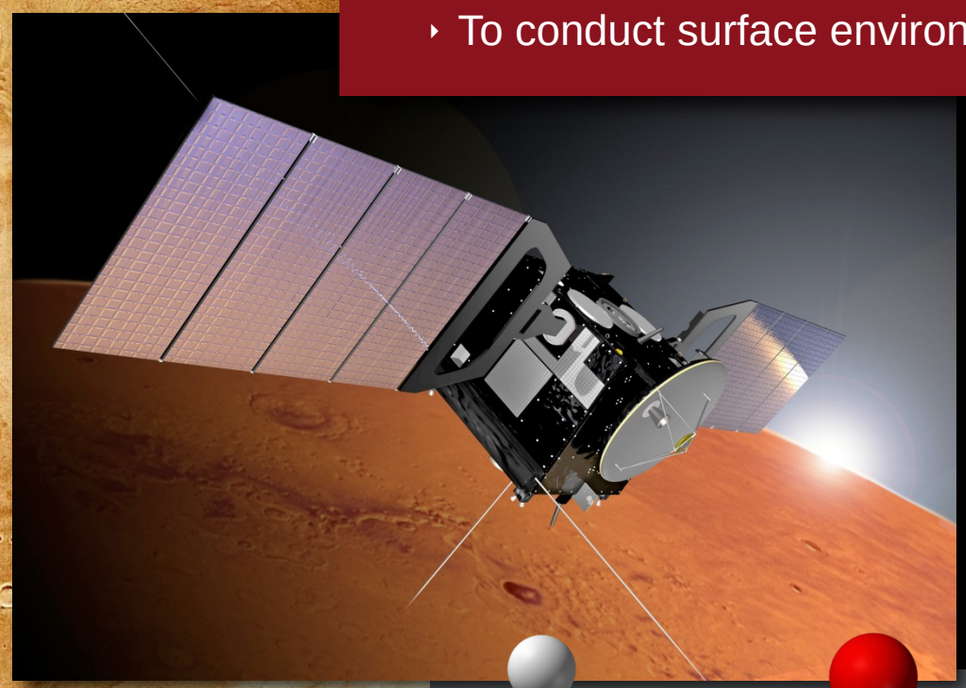
TECHNOLOGY OBJECTIVE

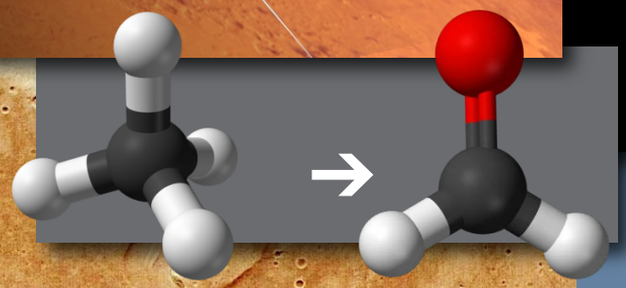
- Entry, Descent, and Landing (EDL) of a payload on the surface of Mars.

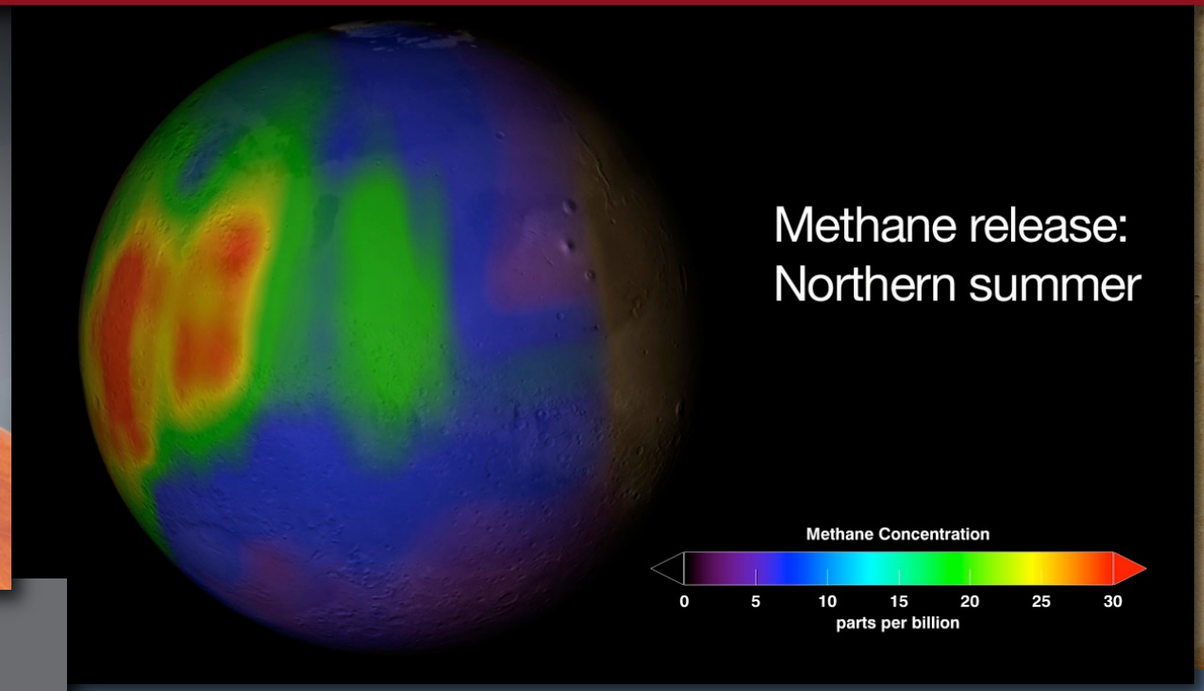
2016

SCIENTIFIC OBJECTIVES

- To study Martian atmospheric trace gases and their sources;
- To conduct surface environment measurements.







- Data relay services for landed missions until 2022.

Credit: MEX/HRSC

Trace Gas Orbiter

E X O M A R S

NOMAD

High-resolution occultation and nadir spectrometers

Atmospheric composition (CH_4, O_3, trace species, isotopes) dust, clouds, P&T profiles

UVIS (0.20 – 0.65 µm) λ/Δλ ~250	SO	Limb	Nadir
IR (2.3 – 3.8 µm) λ/Δλ ~10,000	SO	Limb	Nadir
IR (2.3 – 4.3 µm) λ/Δλ ~20,000	SO		

CaSSIS

High-resolution, stereo camera

Mapping of sources
Landing site selection

ACS

Suite of 3 high-resolution spectrometers

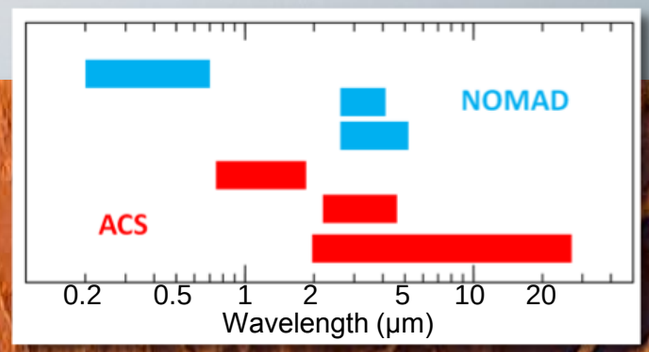
Atmospheric chemistry, aerosols, surface T, structure

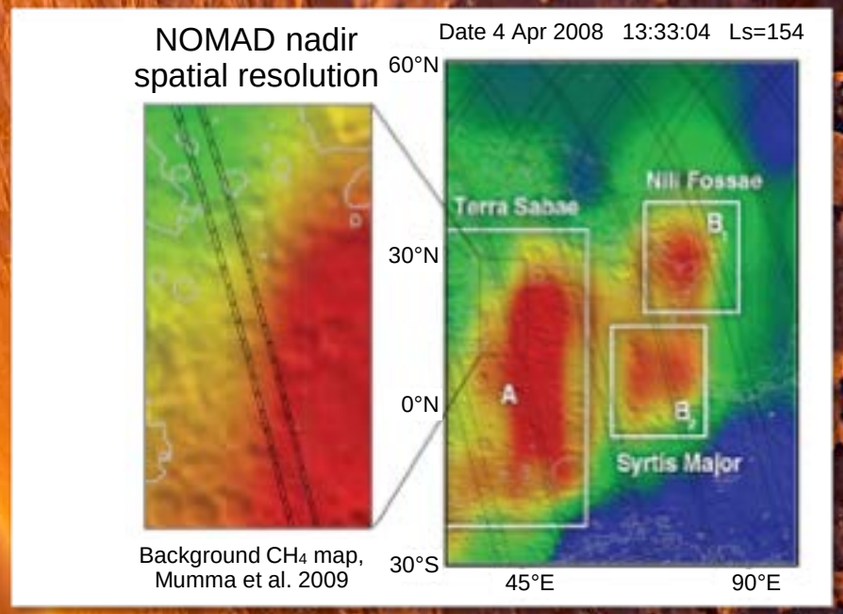
Near IR (0.7 – 1.7 µm) λ/Δλ ~20,000	SO	Limb	Nadir
IR (Fourier, 2.5 – 25 µm) λ/Δλ ~4,000 (SO)/500 (N)	SO		Nadir
IR (2.3 – 4.3 µm) λ/Δλ ~20,000	SO		

FREND

Collimated neutron detector

Mapping of subsurface water and hydrated minerals





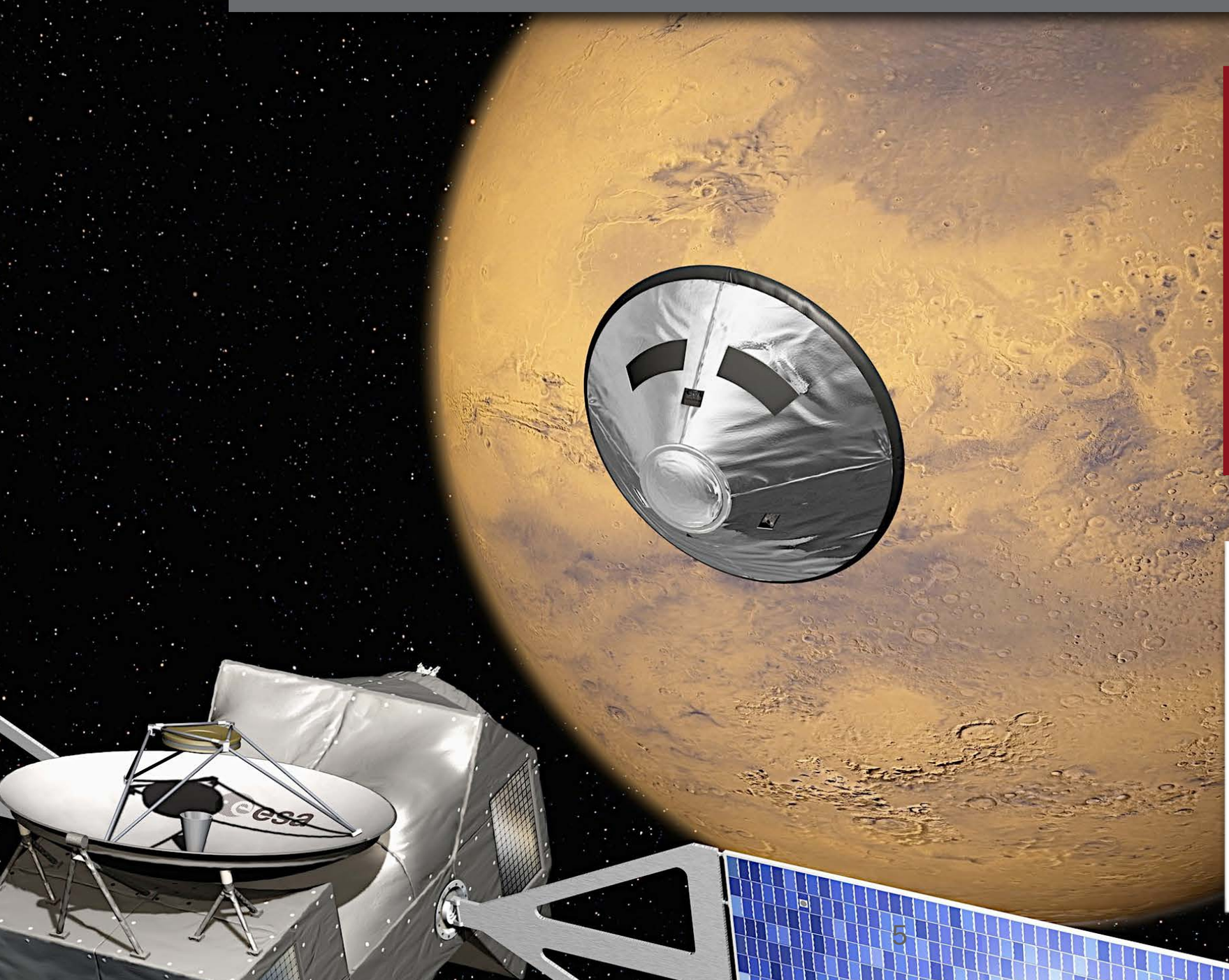
Credit: Kees Veenenbos

EDL Demonstrator Module

EXOMARS

EDM

- A technology demonstrator for landing payloads on Mars;
- A platform to conduct environmental measurements, particularly during the dust storm season.



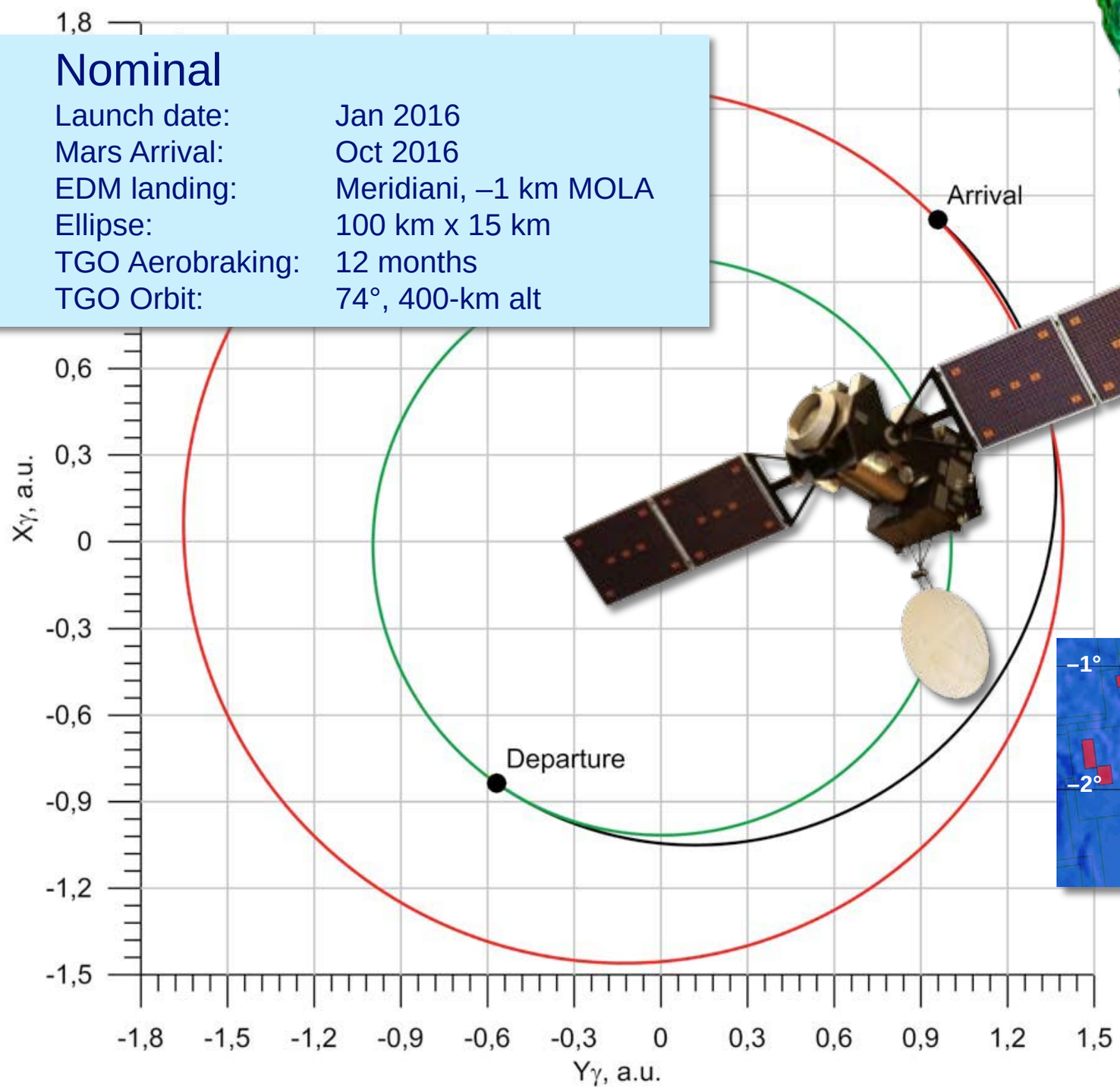
EDM PAYLOAD

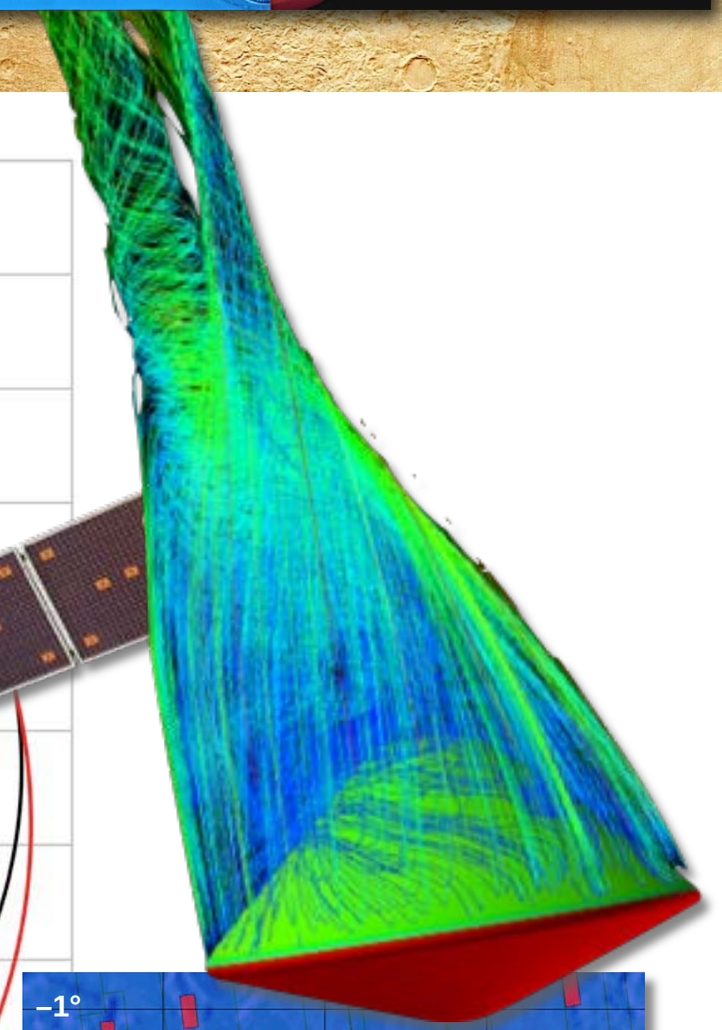
- Integrated mass: 5 kg;
- Surface lifetime: 4–8 sols;
- Measurements:
  - Descent science;
  - P, T, wind speed and direction;
  - Optical depth;
  - Atmospheric charging;
  - Descent camera.

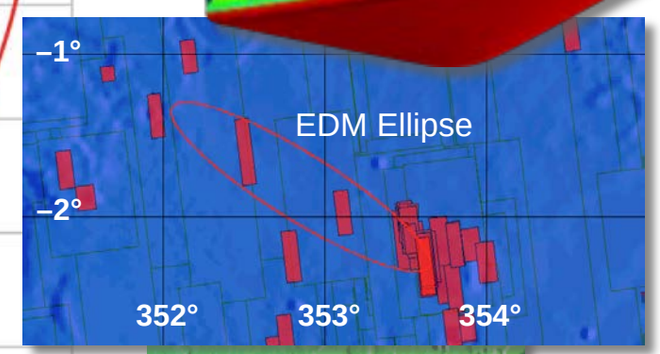
Launch

Nominal

Launch date:	Jan 2016
Mars Arrival:	Oct 2016
EDM landing:	Meridiani, –1 km MOLA
Ellipse:	100 km x 15 km
TGO Aerobraking:	12 months
TGO Orbit:	74°, 400-km alt







Credit: MEX/HRSC

2016 Planetary Protection

EXOMARS

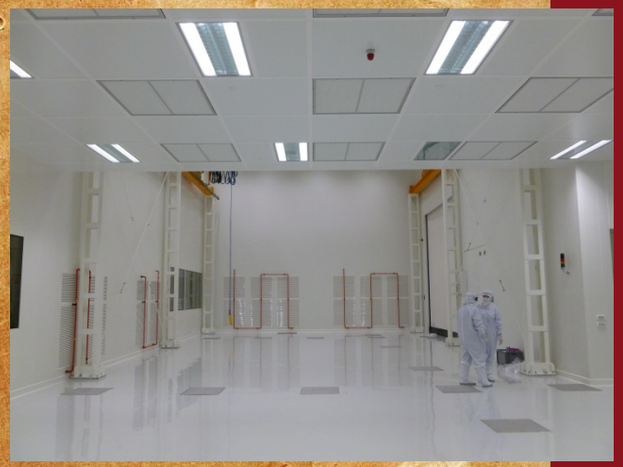
2016

PROJECT PLANETARY PROTECTION STATUS

- Planetary Protection Category IVa for EDM and Category III for TGO;
- Project baseline is orbital lifetime approach (currently under review at CDR);
- ESA bioburden reserve is 20% (additional reserve at industrial Prime level).

PRACTICAL IMPLEMENTATION

- New bioburden controlled ISO 7 cleanroom at industrial Prime site completed;
- New microbiological laboratory at industrial Prime site completed;
- Use of newly approved rapid assay procedure;
- Use of new bioburden accounting database with approved sample tool efficiencies and simplified analysis;
- Training of personnel ongoing;
- First last access assays on flight hardware started in April 2013;
- First launch site reconnaissance visit completed.



Credit: MEX/HRSC

2018 Mission Objectives

EXOMARS

2018

SCIENTIFIC OBJECTIVES

- To search for signs of past and present life on Mars;
- To investigate the water/subsurface environment as a function of depth in the shallow subsurface.

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.

- To characterise the surface environment.

- Russian deep-space communications stations to work with ESA's ESTRACK;
- Russian computer for ExoMars landed operations;
- Throttleable braking engines for planetary landing.

Credit: MEX/HRSC

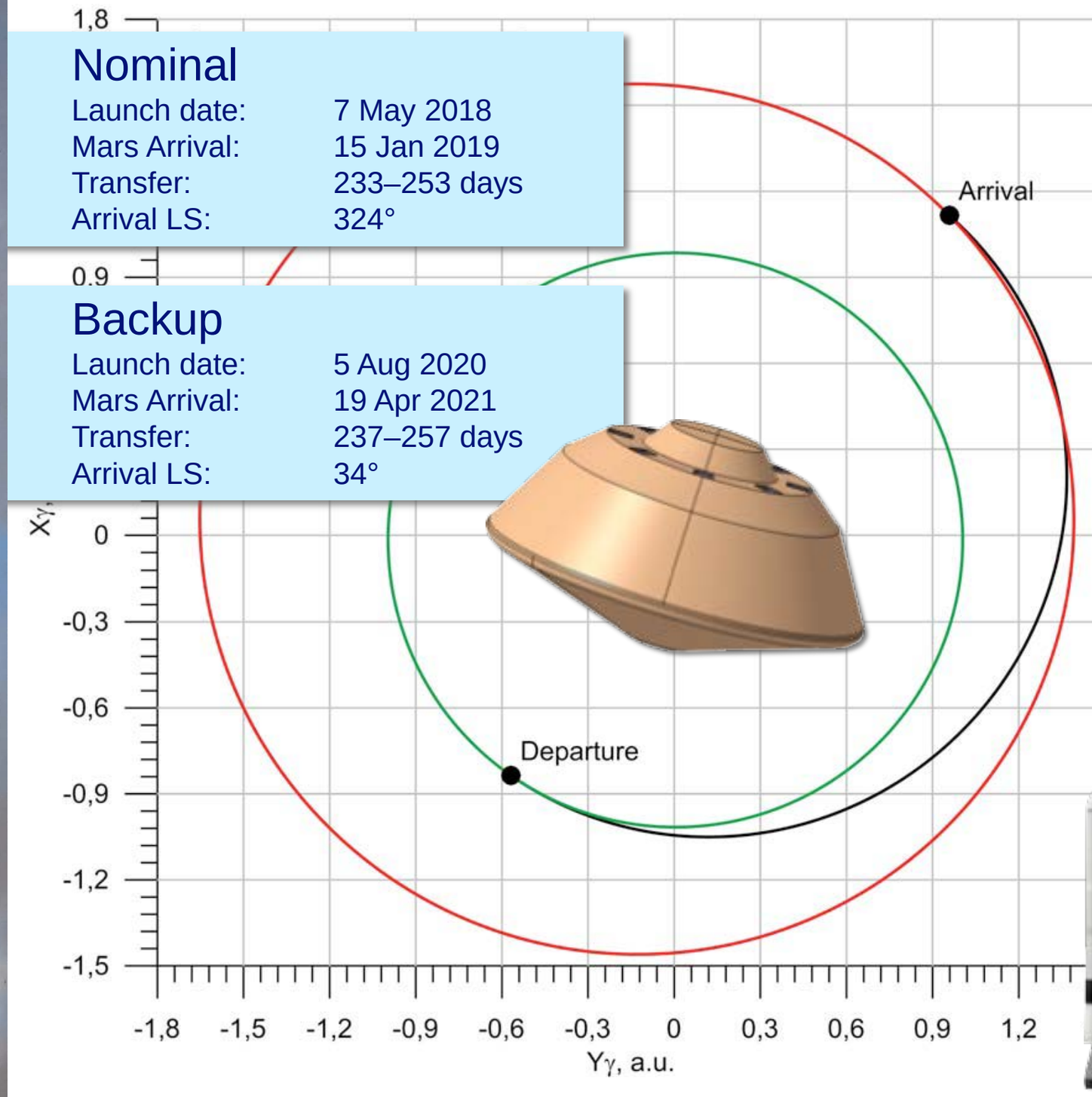
Launch

Nominal

Launch date:	7 May 2018
Mars Arrival:	15 Jan 2019
Transfer:	233–253 days
Arrival LS:	324°

Backup

Launch date:	5 Aug 2020
Mars Arrival:	19 Apr 2021
Transfer:	237–257 days
Arrival LS:	34°

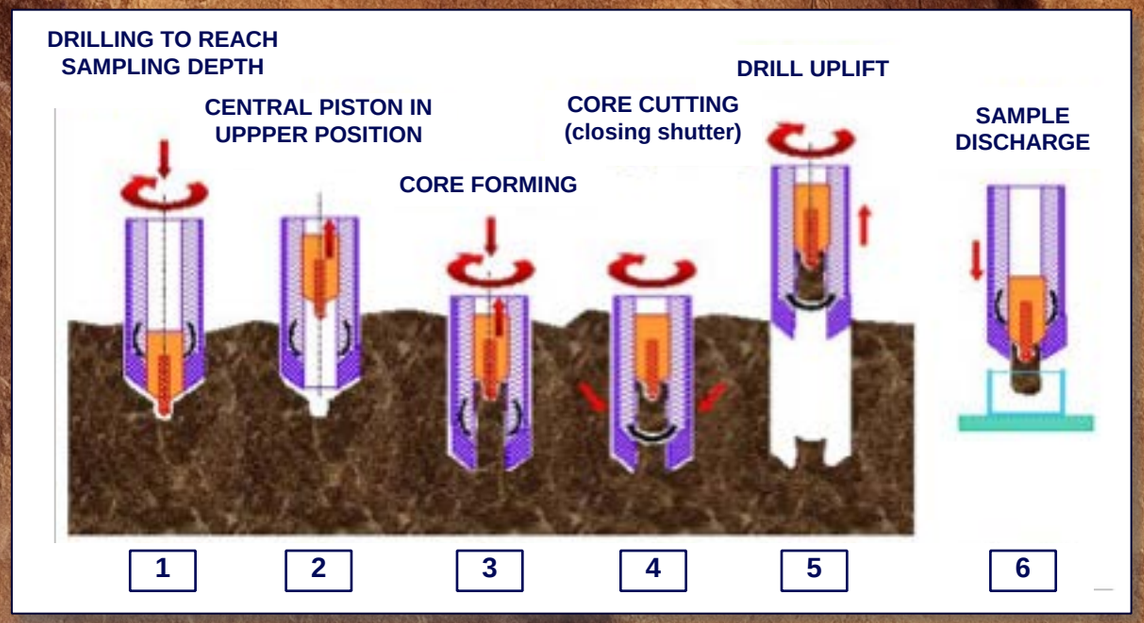


Credit: MEX/HRSC

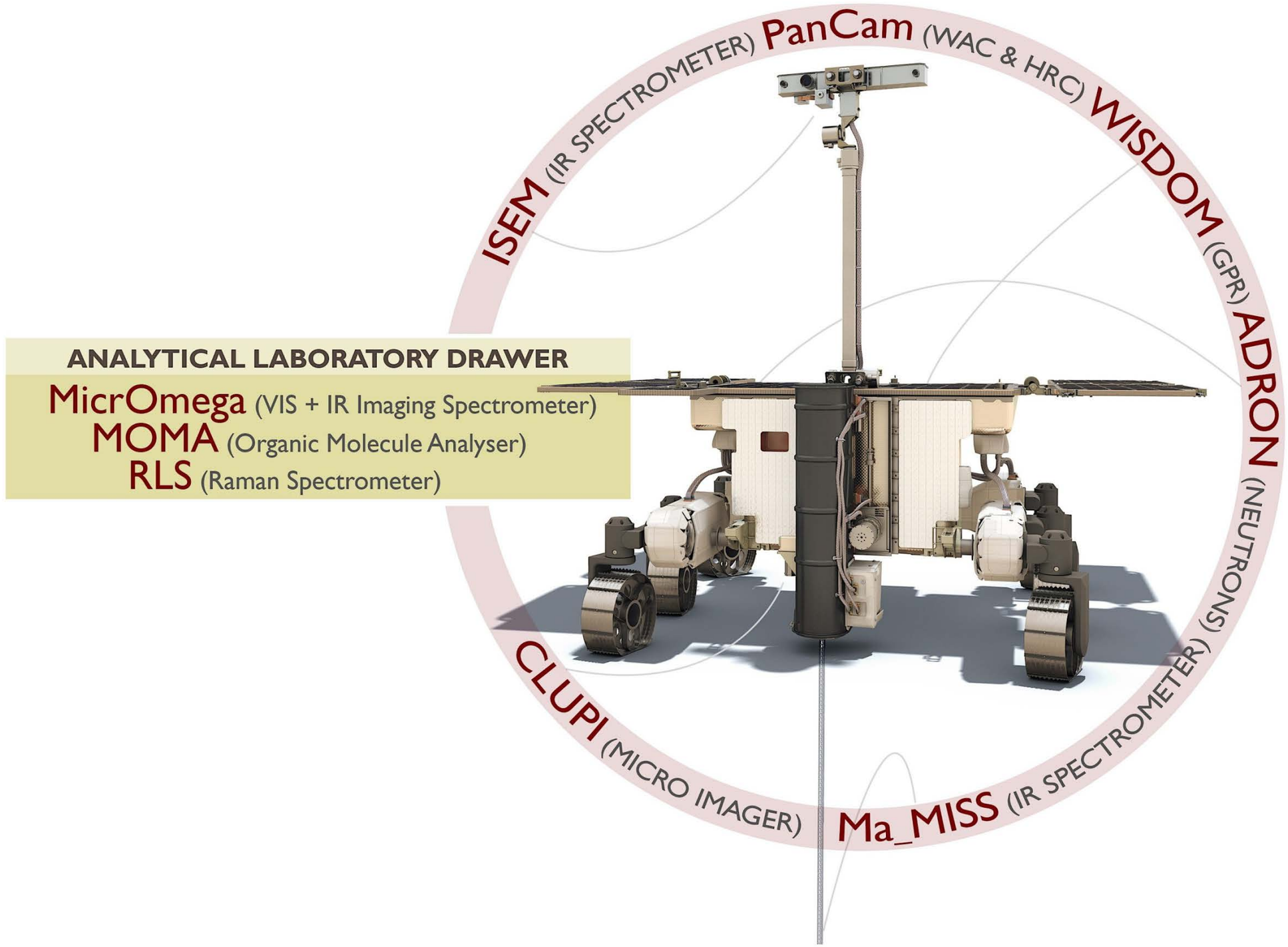
Mobility + Subsurface Access

Credit: ESA/Medialab

Nominal mission :	218 sols
Nominal science :	6 Experiment Cycles + 2 Vertical Surveys
EC length :	16–20 sols
Rover mass :	300-kg class
Mobility range :	Several km



Pasteur Payload

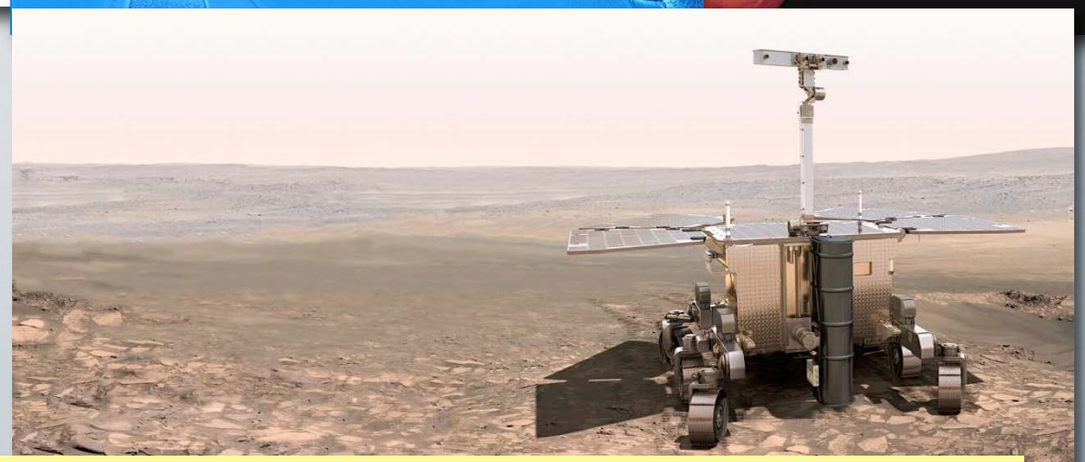


ANALYTICAL LABORATORY DRAWER

MicrOmega (VIS + IR Imaging Spectrometer)
MOMA (Organic Molecule Analyser)
RLS (Raman Spectrometer)

Pasteur Payload

EXOMARS



PanCam

Wide-angle stereo camera pair
High-resolution camera

Geological context
Rover traverse planning
Atmospheric studies

WAC: 35° FOV, HRC: 5° FOV

ISEM

IR spectrometer on mast

Bulk mineralogy of outcrops
Target selection

λ = 1.15 – 3.3 µm, 1° FOV

CLUPI

Close-up imager

Geological deposition environment
Microtexture of rocks
Morphological biomarkers

20-µm resolution at 50-cm distance, focus: 20 cm to ∞

WISDOM

Ground-penetrating radar

Mapping of subsurface stratigraphy

3 – 5-m penetration, 2-cm resolution

ADRON

Passive neutron detector

Mapping of subsurface water and hydrated minerals

Drill + Ma_MISS

IR borehole spectrometer

In-situ mineralogy information

λ = 0.4 – 2.2 µm

Analytical Laboratory Drawer

MicrOmega

VIS + IR spectrometer

Mineralogy characterisation of crushed sample material
Pointing for other instruments

λ = 0.9 – 3.5 µm, 256 x 256, 20-µm/pixel, 500 steps

RLS

Raman spectrometer

Geochemical composition
Detection of organic pigments

spectral shift range 200–3800 cm^{-1}, resolution ≤ 6 cm^{-1}

MOMA

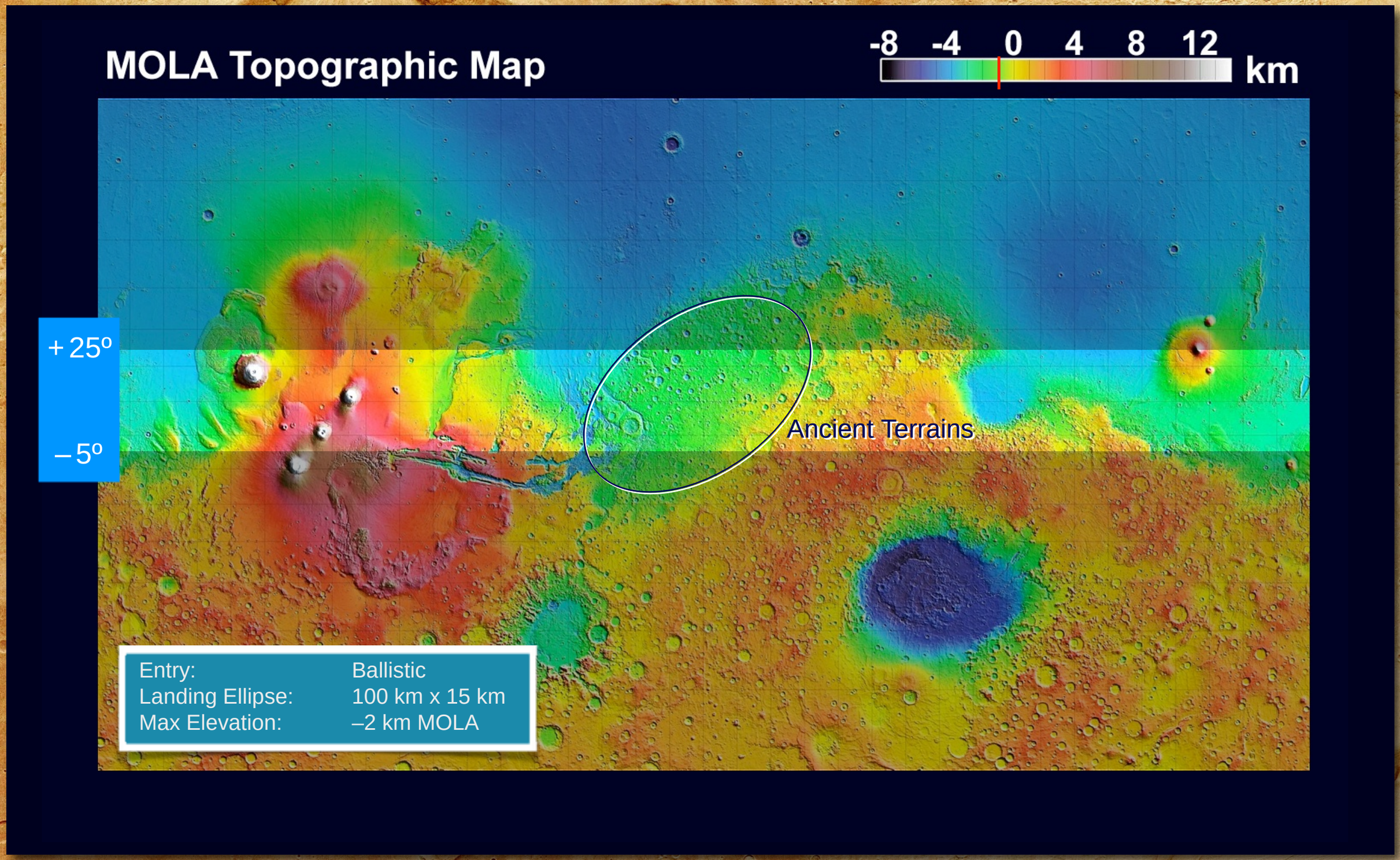
LDMS + Pyr-Dev GCMS

Broad-range organic molecules with high sensitivity (ppb)
Chirality determination

Laser desorption extraction and mass spectroscopy

Pyrolisis extraction in the presence of derivatisation agents, coupled with chiral gas chromatography, and mass spectroscopy

Landing Latitudes



Credit: MEX/HRSC

2018 Planetary Protection

EXOMARS

2018

PROJECT PLANETARY PROTECTION STATUS

- Planetary Protection Category IVb;
- Bioburden allocation for flight systems agreed between ESA and Roskosmos during S-SRR;
- Rover PDR and ALD PDR completed.

PRACTICAL IMPLEMENTATION

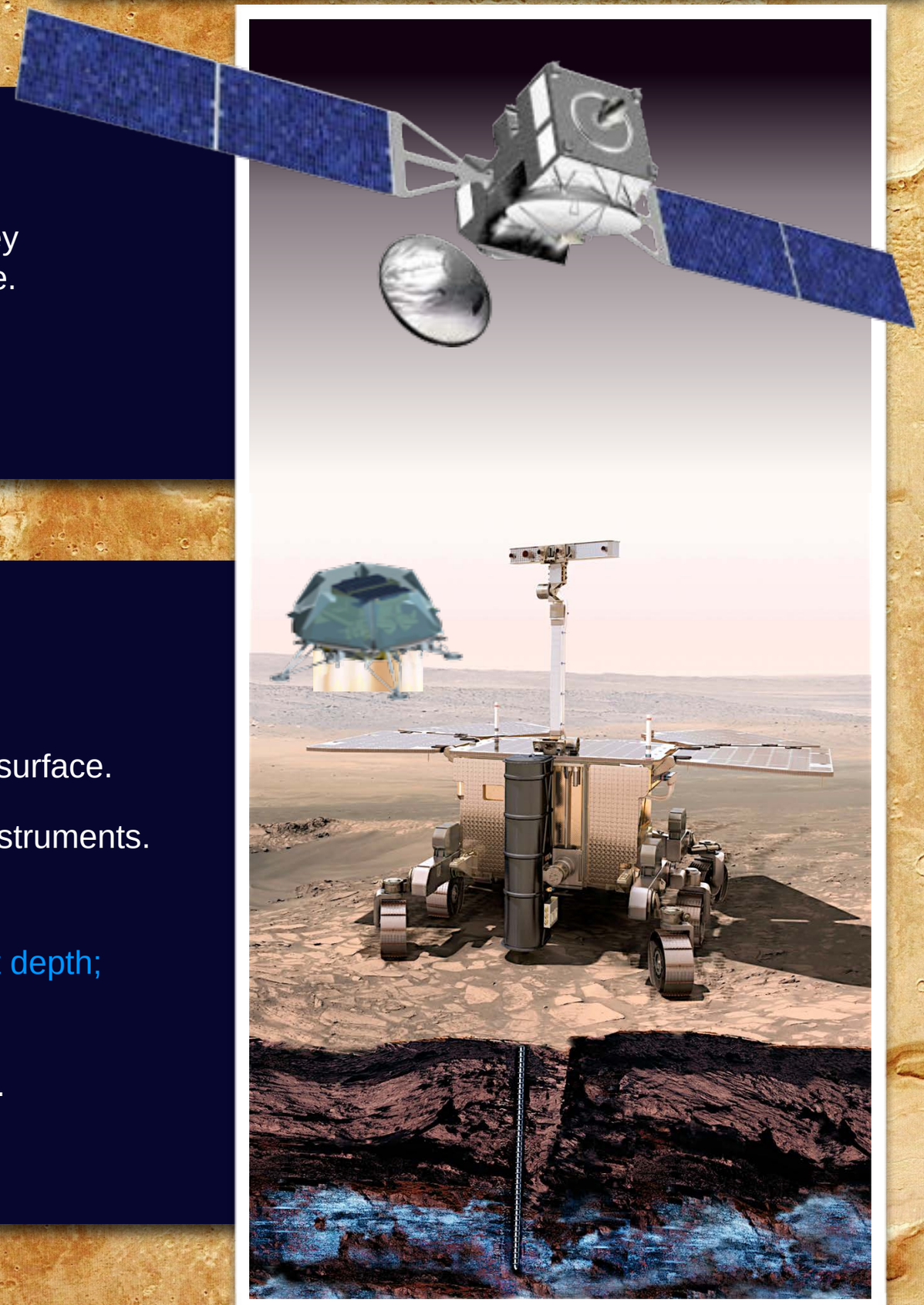
- Similar to ExoMars 2016, including use of facilities;
- Final tailoring of cleaning and sterilization processes;
- Planning for dedicated ALD assembly environment underway.

Credit: MEX/HRSC

Conclusions

2016: ExoMars Trace Gas Orbiter

- Its science will improve our understanding of Mars and of key atmospheric processes of potential astrobiological relevance.
- An excellent base for international collaboration.
- Master landing technologies for future exploration missions.



2018: ExoMars Rover and SP

- A great exobiology mission.
- The first ever to combine mobility with access to the subsurface.
- The rover's Pasteur payload contains next-generation instruments.
- The rover will study for the first time:
  - Organics and biomarkers for past and present life at depth;
  - Vertical characterisation of geochemistry and water.
- The SP will perform novel environmental measurements.
- A step closer to Mars Sample Return.

Credit: MEX/HRSC