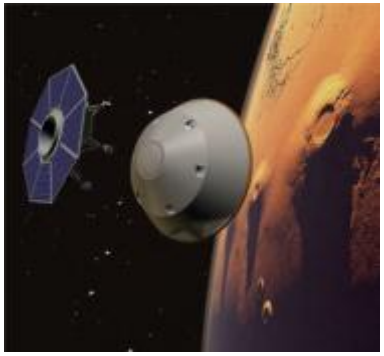
EXOMARS PROJECT
2018 Mission



ExoMars Rover Mission Overview

Planetary Rover Workshop
ICRA 10th May 2013

Pietro Baglioni, Luc Joudrier
& ExoMars Rover Team

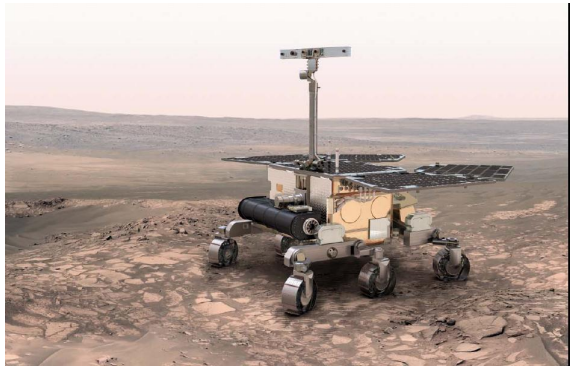


Table of Content

ExoMars Objectives

•Technology Objectives

- European capability to land payloads on Mars
- Mars surface mobility
- Subsurface sample acquisition capability
- In situ Sample Processing and Handling capability

•Scientific Objectives

- To search for traces of past and present life on Mars;
- To characterise the water/geochemical environment as a function of depth in the shallow subsurface;
- To study the surface environment and identify hazards to future human missions
- To study Martian atmosphere

ExoMars Missions Architecture

- *Two missions , to be launched in 2016 and 2018*
  - The 2016 mission consists of a Trace Gas Orbiter (TGO) and an EDL Demonstrator Module (EDM)
  - The 2018 mission consists of a Carrier Module (CM) and a Descent Module (DM) which accommodates the Rover
- *Large international cooperation with Roscosmos (ROS) and some contributions from NASA*

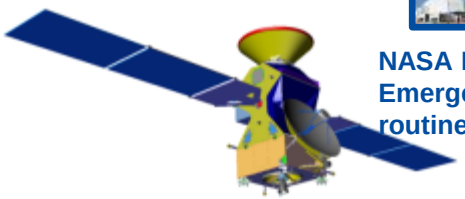
2016 Mission

AND

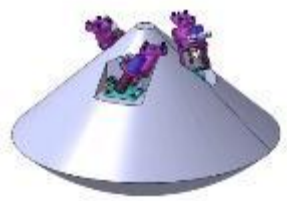
2018 Mission

Proton

Trace Gas Orbiter (TGO)



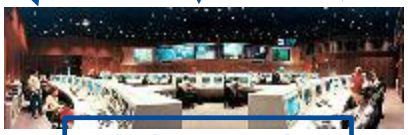
EDL Demonstrator Module (EDM)



NASA DSN Emergencies and routine (TBC)

ESA ESTRACK

ROS DSN (TBC)

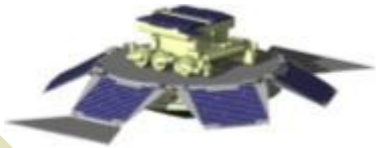


Mission Operation Centre (MOC) @ ESOC

Science Operations Centre (SOC) @ ESAC (TBC)

Proton

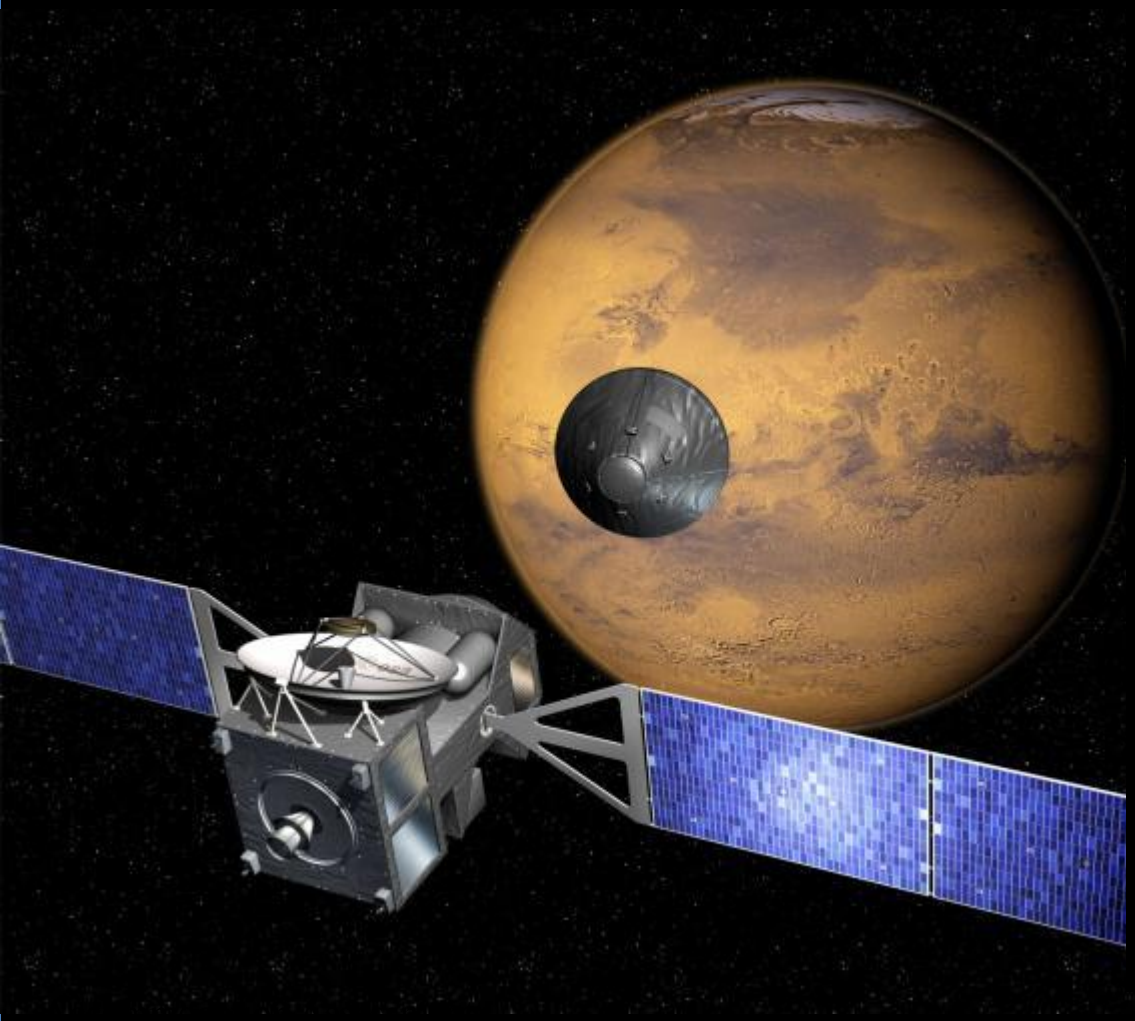
Carrier Module & Descent Module



Rover Module (RM)

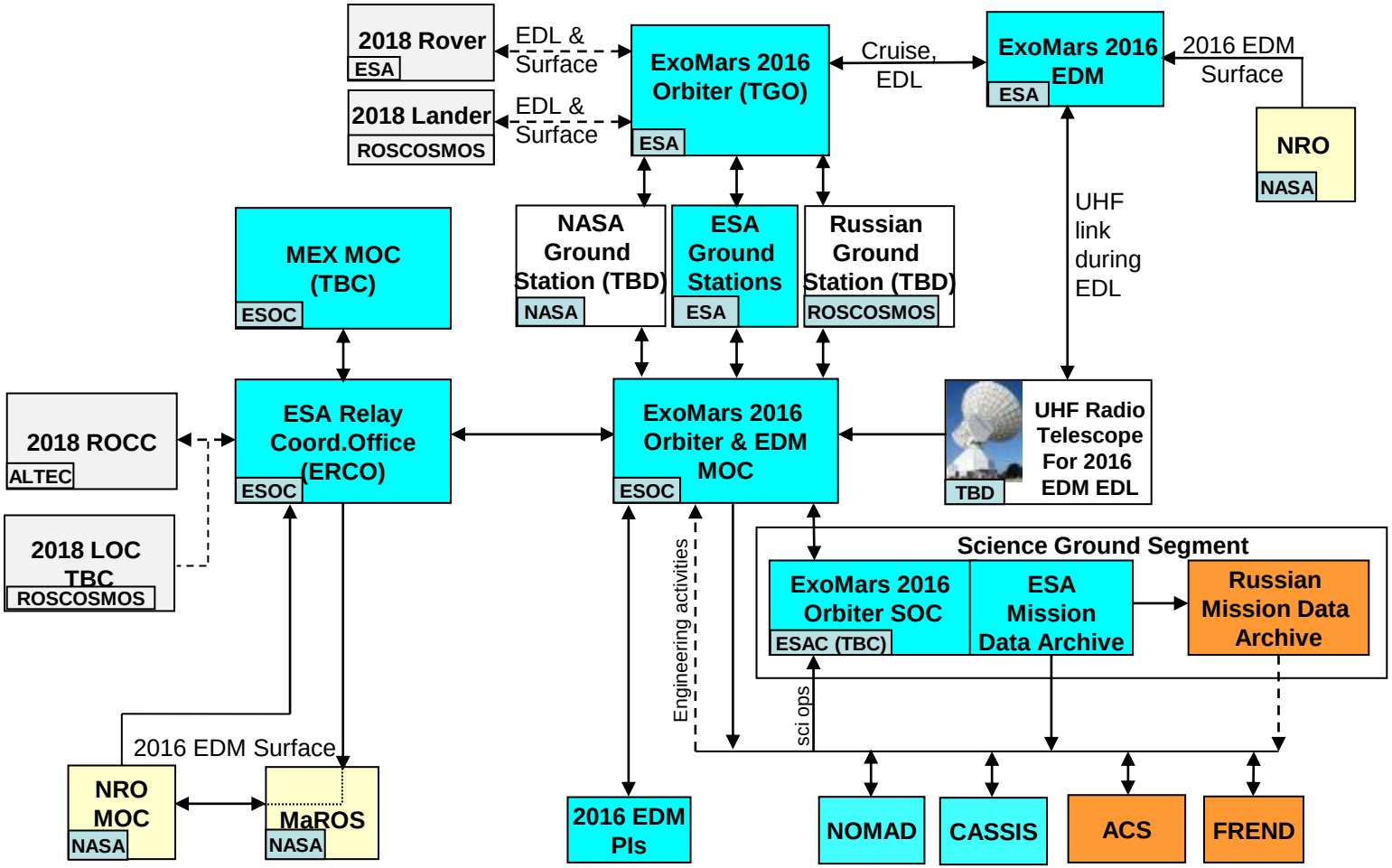
ROC & LOC

2016 Mission Flight Segment - TGO and EDM

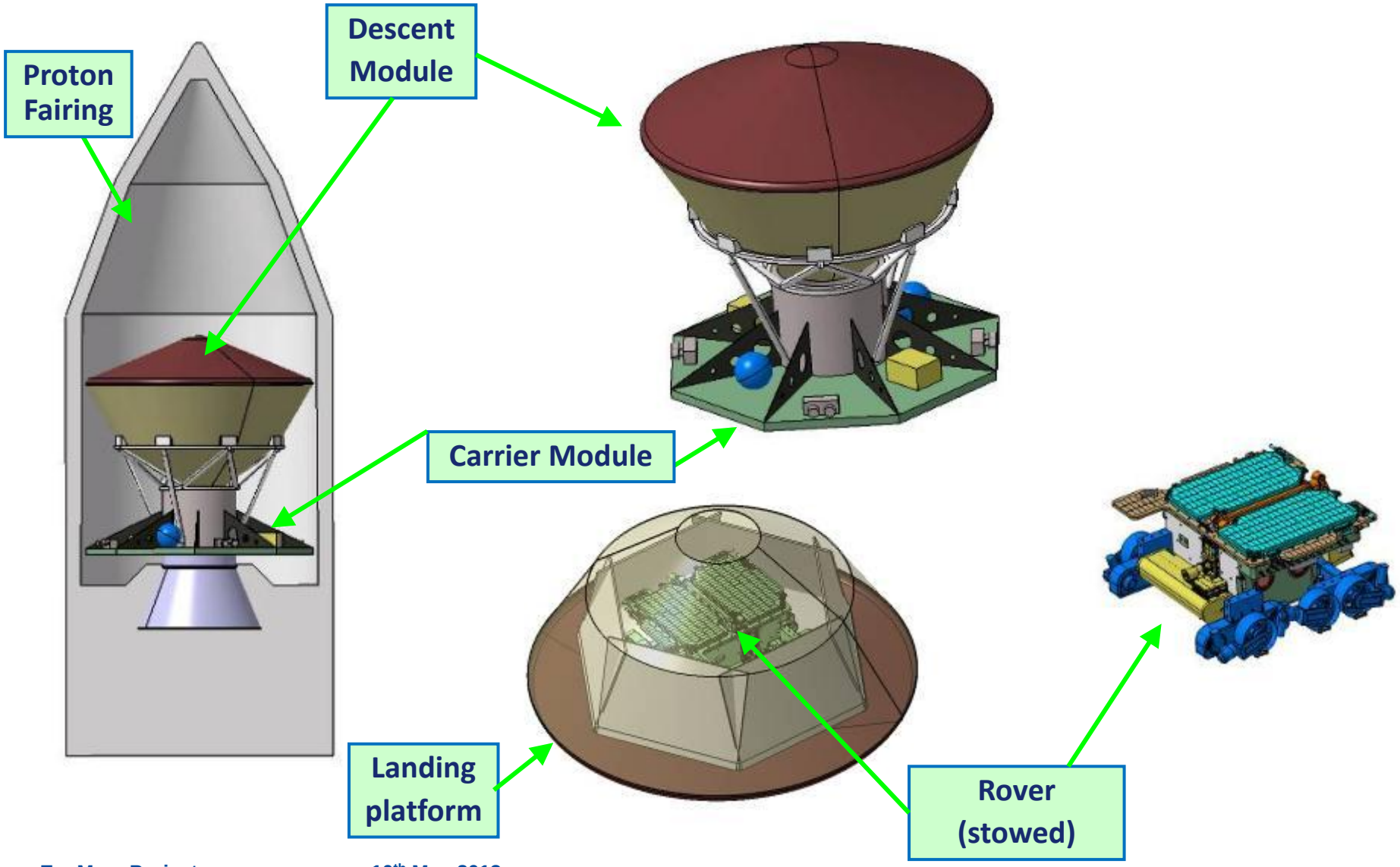


- Launch: Jan 2016
- Mass at launch: 4332 kg
- TGO Instruments Mass: ~116 kg
- EDM release and MOI: Oct 2016
- Short Duration Lander surface science
- Aerobraking ~ 1 year incl. ~ 3 months of superior conjunction wait-out
- Science Phase 1 Martian year for trace gas science
- Data relay services through end of 2022

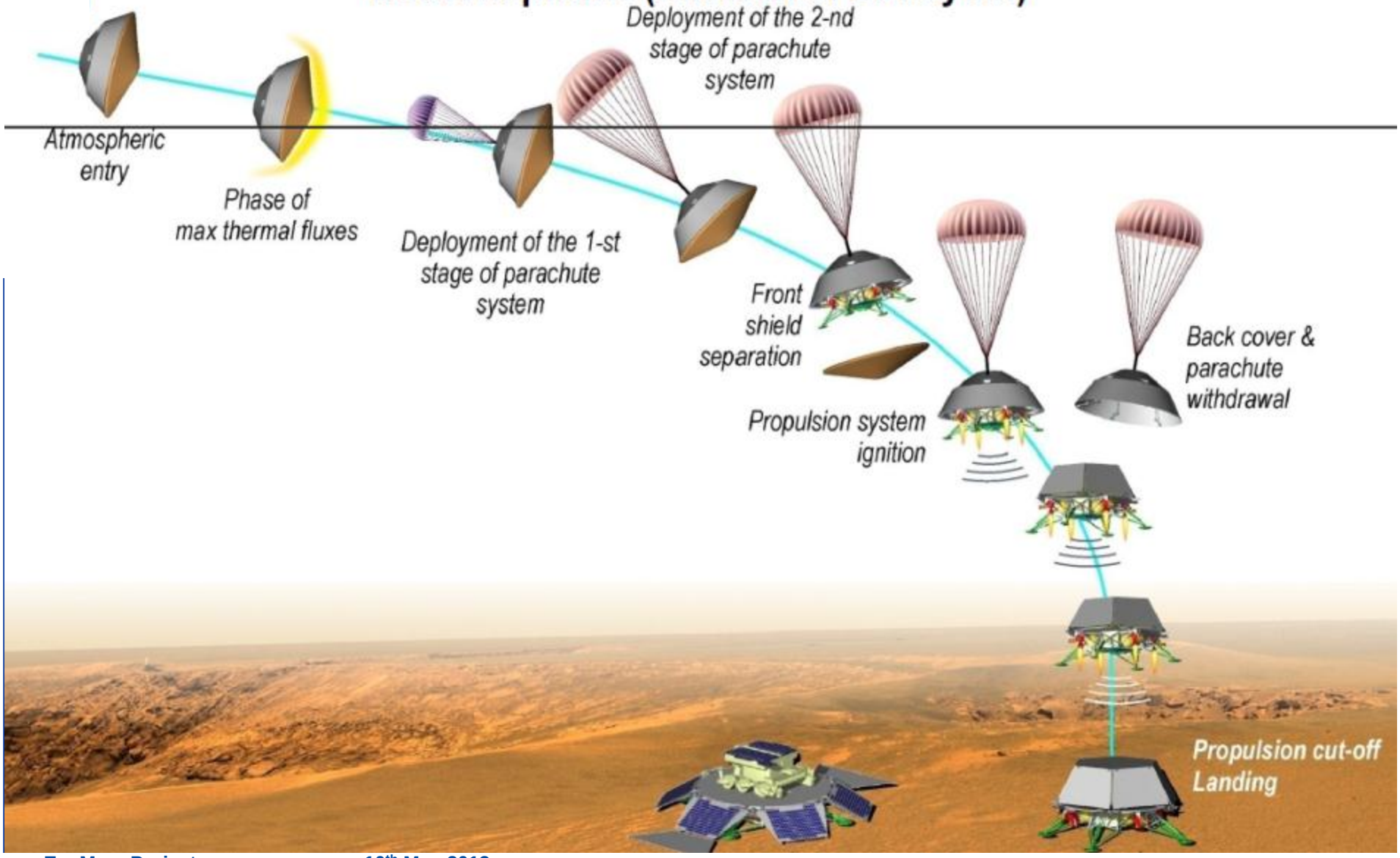
EXM Ground Segment Architecture



2018 Mission Flight Segment – CM, DM and RM

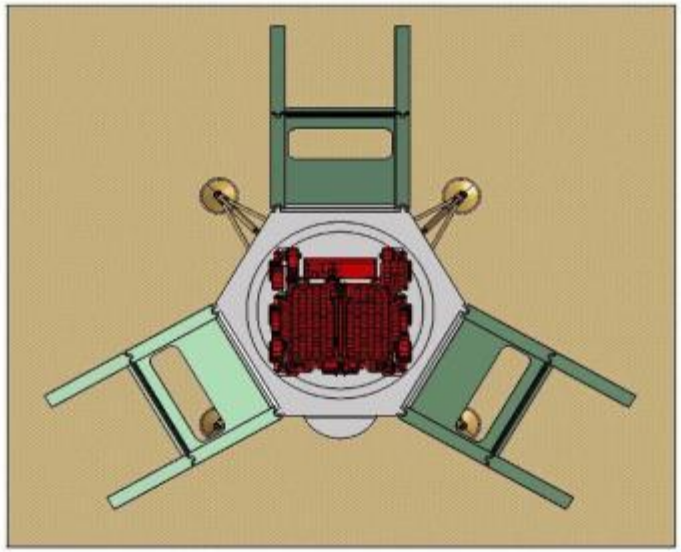


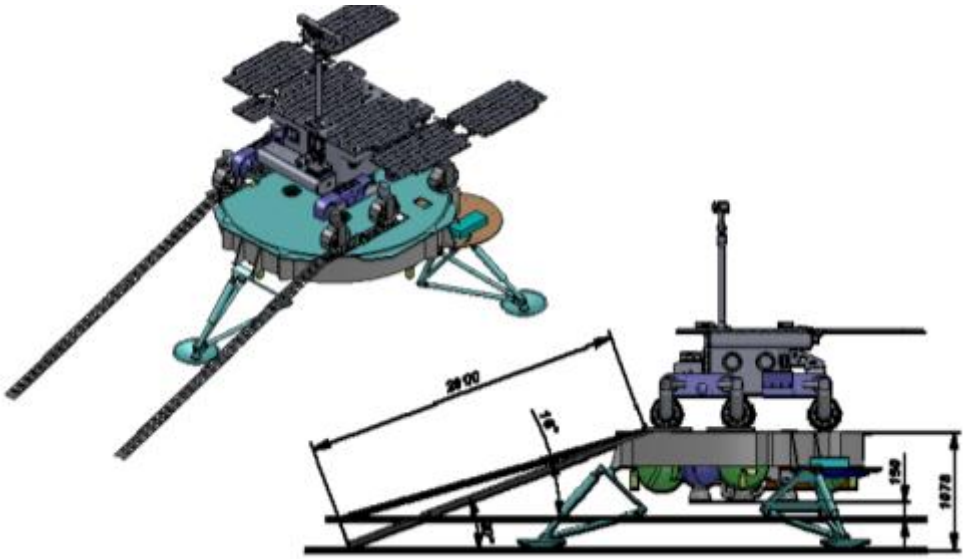
Descent profile (mission of 2018 year)



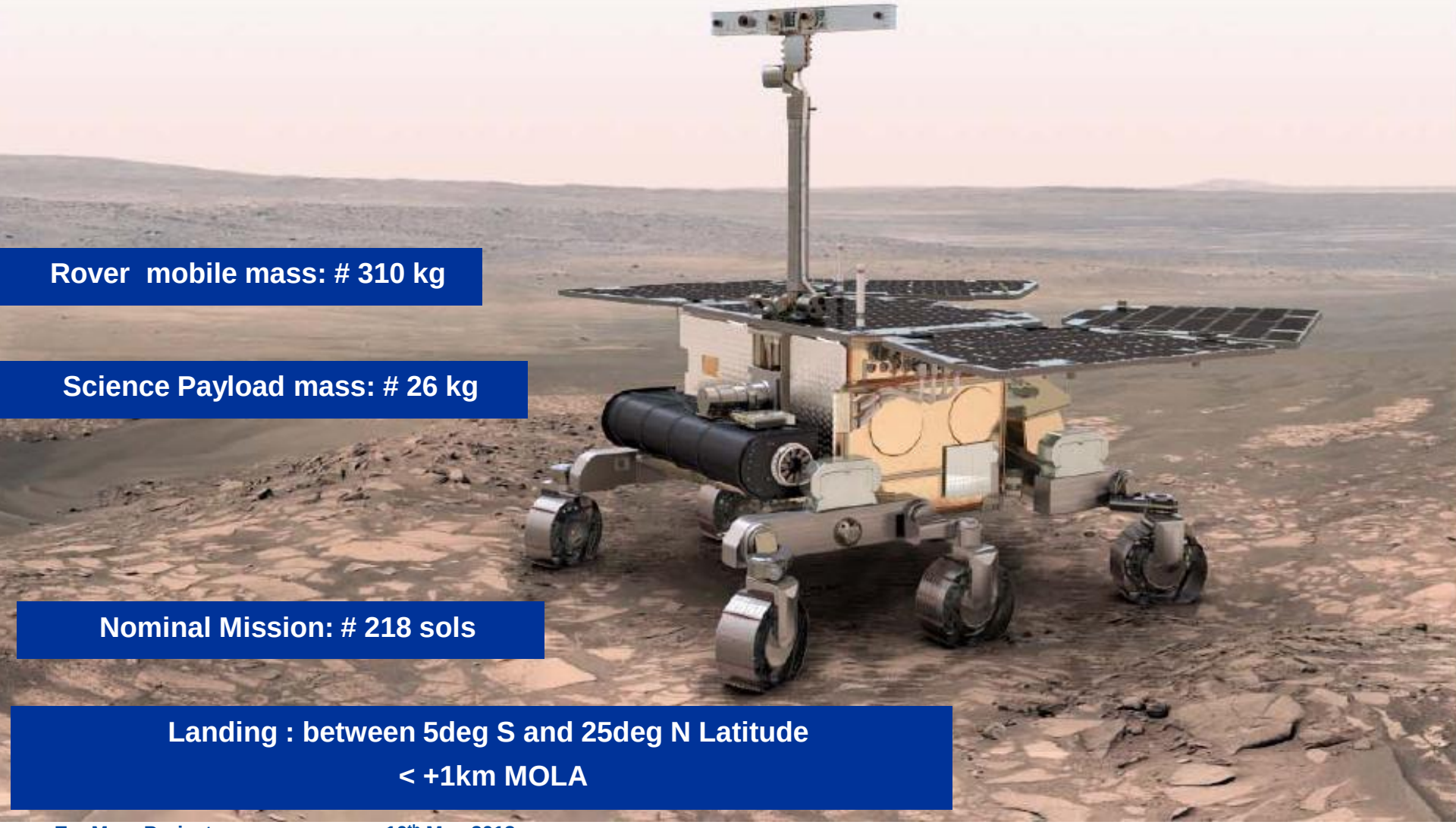
Rover Egress Options & Sequence under study

Lavochkin (Russia), in charge of the 2018 DM design, is currently studying various options for the accommodation of the Rover, including its deployment and egress scenario, and of scientific instruments on the landing platform.
The Rover mobility system is providing self rising capabilities.





The ExoMars Rover



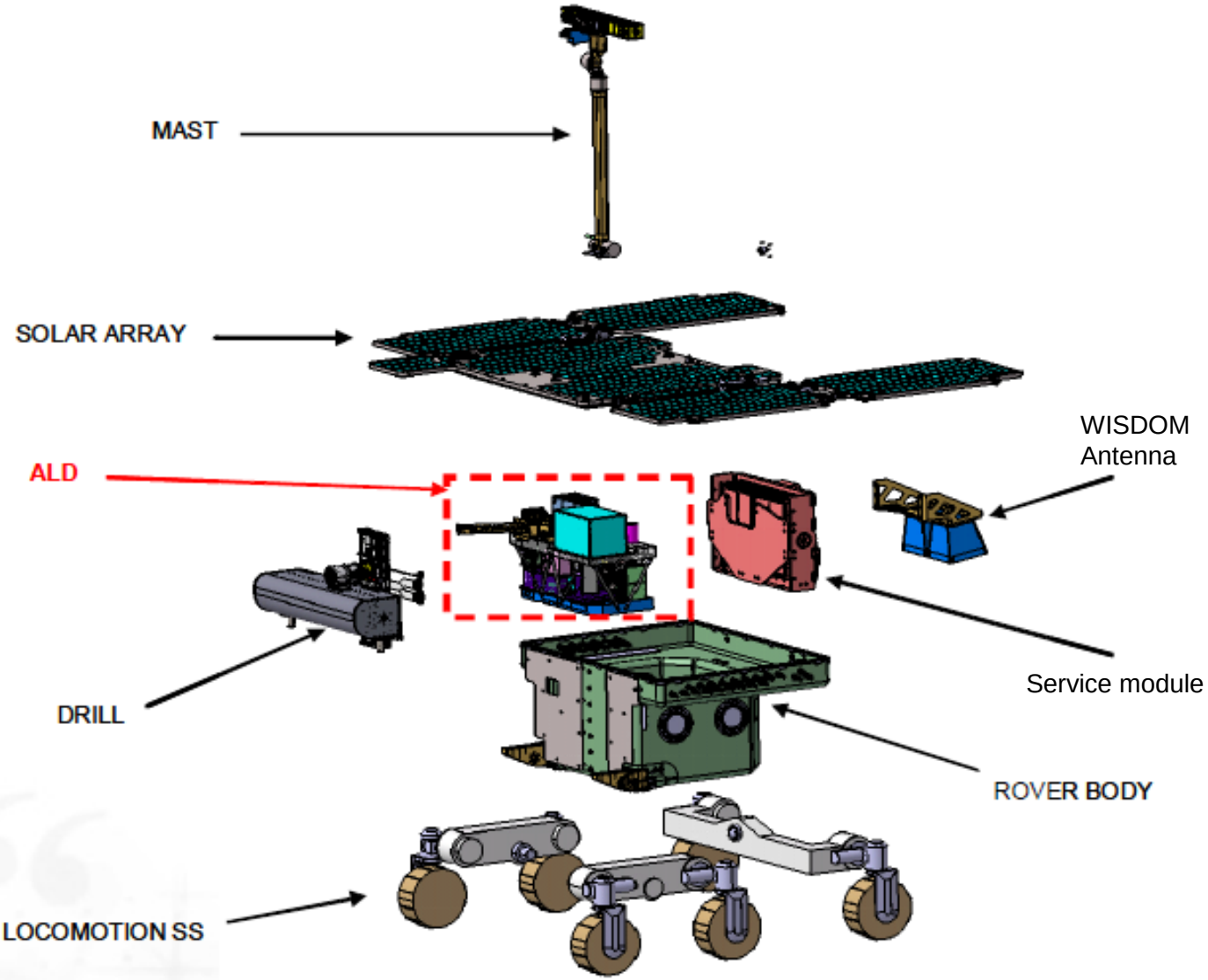
Rover mobile mass: # 310 kg

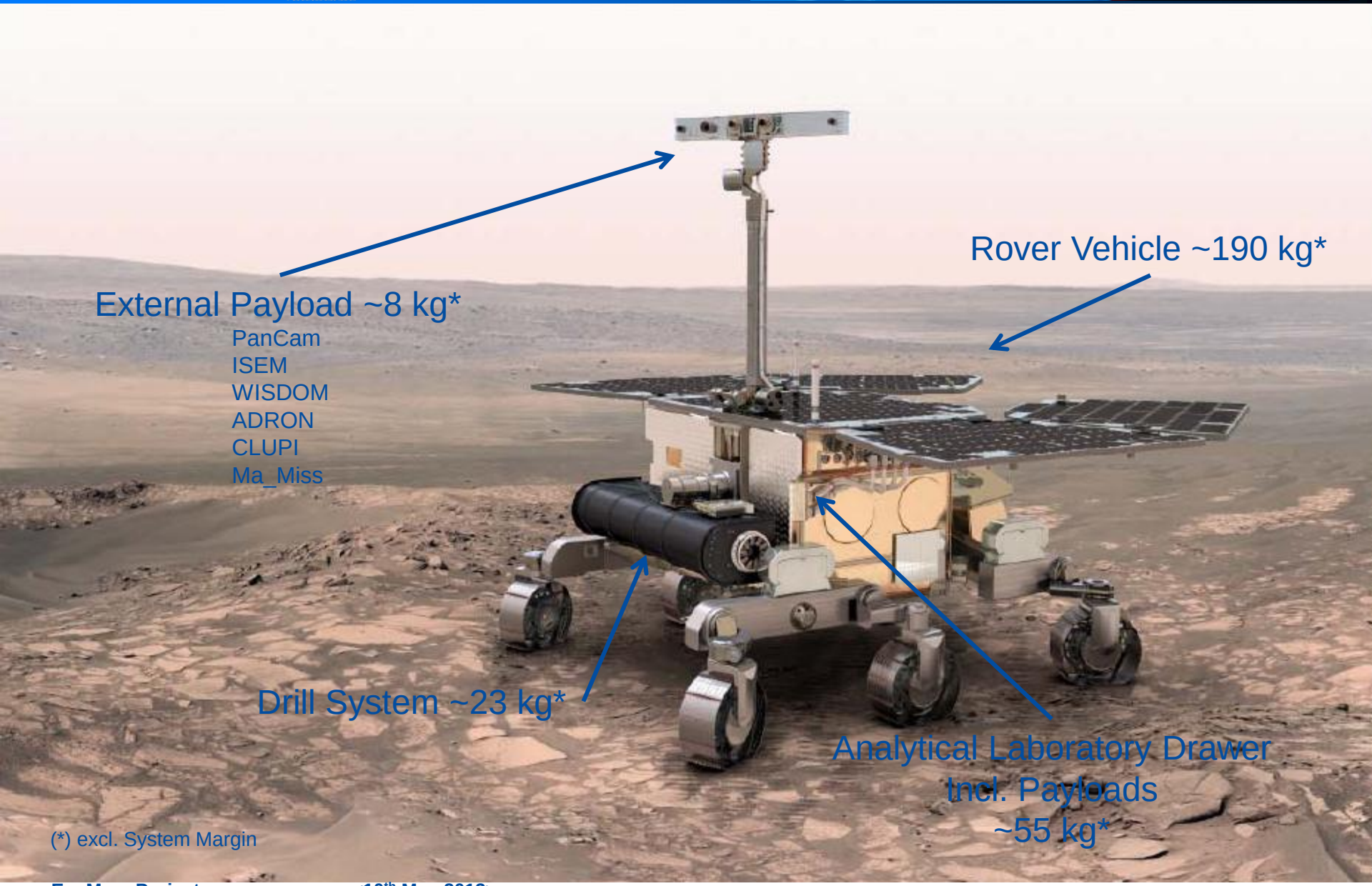
Science Payload mass: # 26 kg

Nominal Mission: # 218 sols

Landing : between 5deg S and 25deg N Latitude
< +1km MOLA

Rover configuration





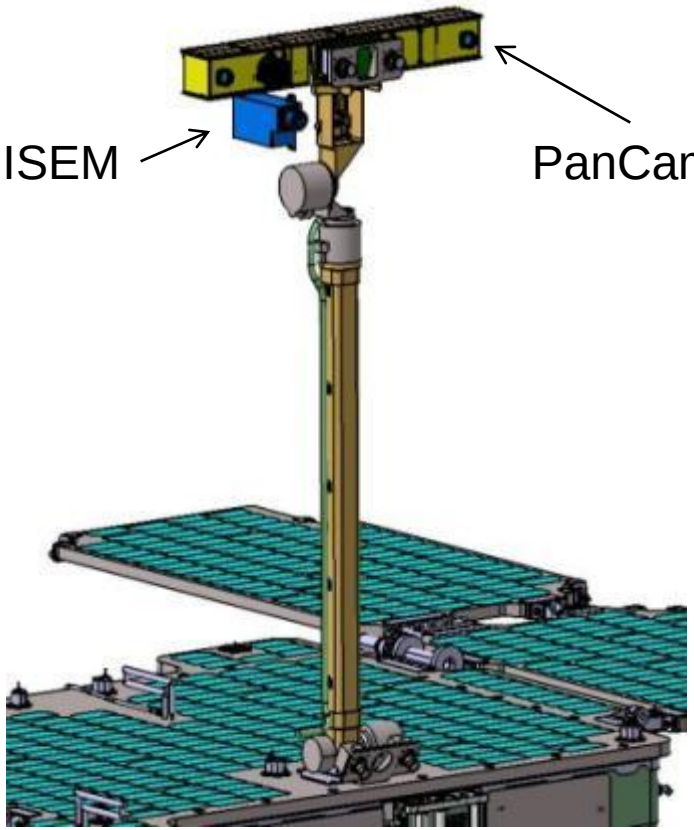
(*) excl. System Margin

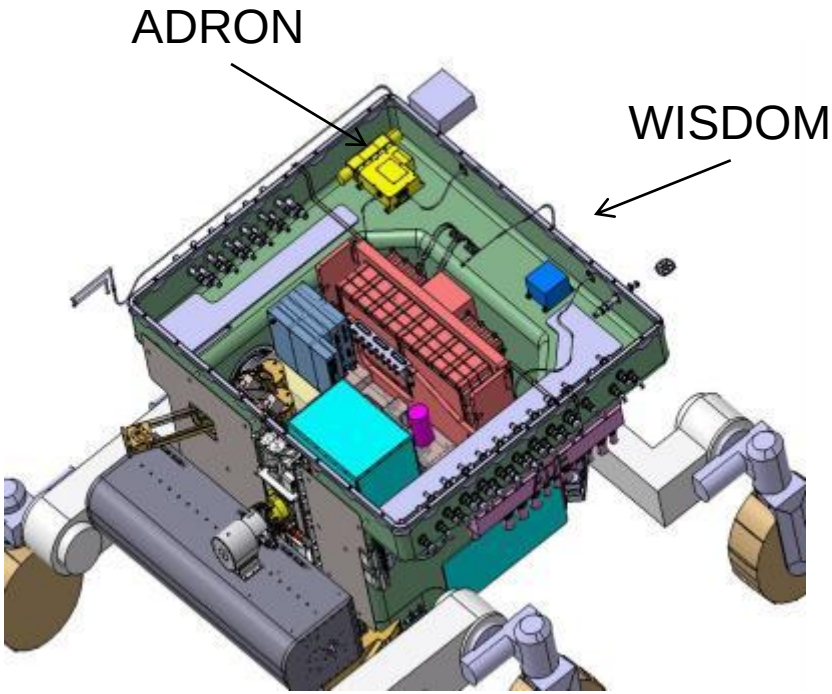
ExoMars Rover Scientific Payload

❑ **Pasteur Payload set is composed by 9 scientific instruments:**

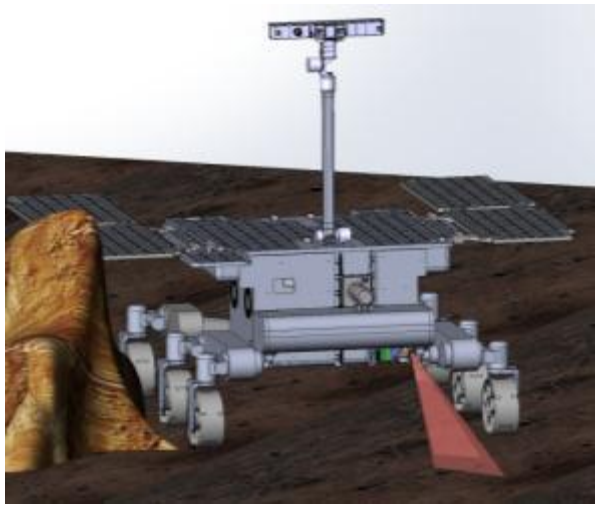
- **Mounted on the Rover Vehicle**
  - PanCam (Panoramic Cameras): Wide Angle multi-spectral stereoscopic Hi Res pan images
  - WISDOM (Water Ice & Subsurface Deposit Observations on Mars): a polarimetric ground-penetrating radar
  - IR Spectrometer (ISEM – *IKI (Ru)*)
  - Neutron Detector (ADRON – *IKI (Ru)*)
- **Mounted on the Drill**
  - Ma_Miss (Mars Multispectral Imager for Sub-surface Science): wide-range infrared spectrometer to conduct mineralogical investigations.
  - CLUPI: Close Up Imager
- **Mounted inside the ALD**
  - MicrOmega: Infrared Microscope for hyperspectral imaging
  - RLS (Raman Laser Spectrometer)
  - MOMA (Mars Organic Molecule Analyser): Laser Desorption / Gas Chromatographer / Mass Spectrometer

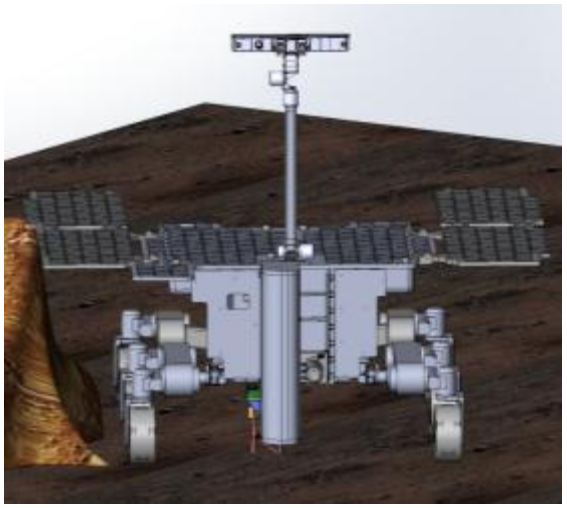
PanCam, ISEM, ADRON, WISDOM

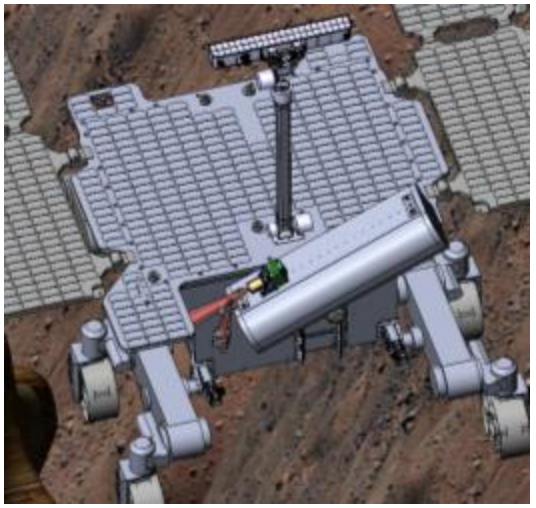


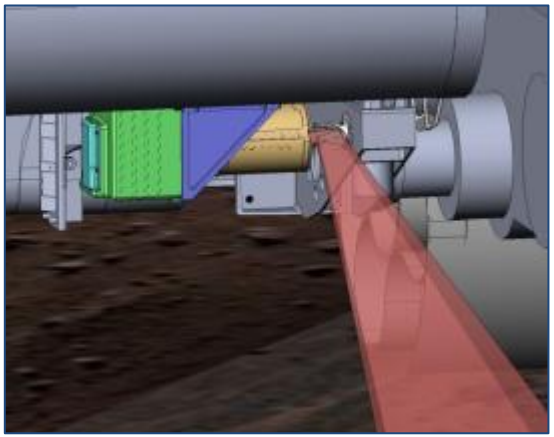


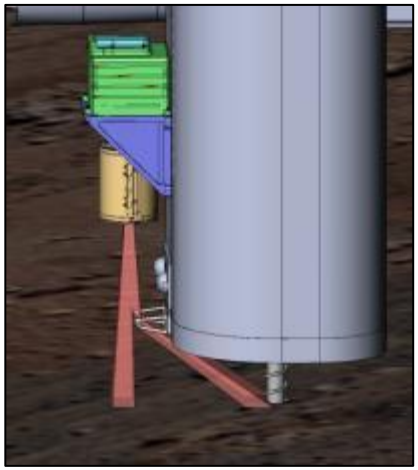
CLUPI

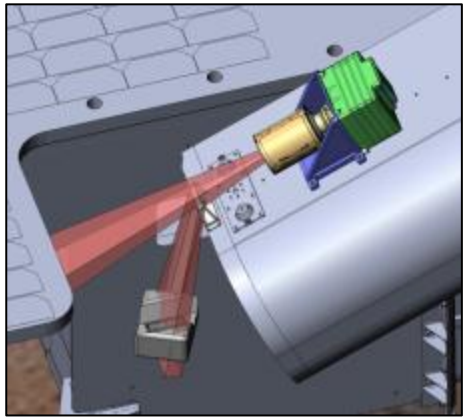










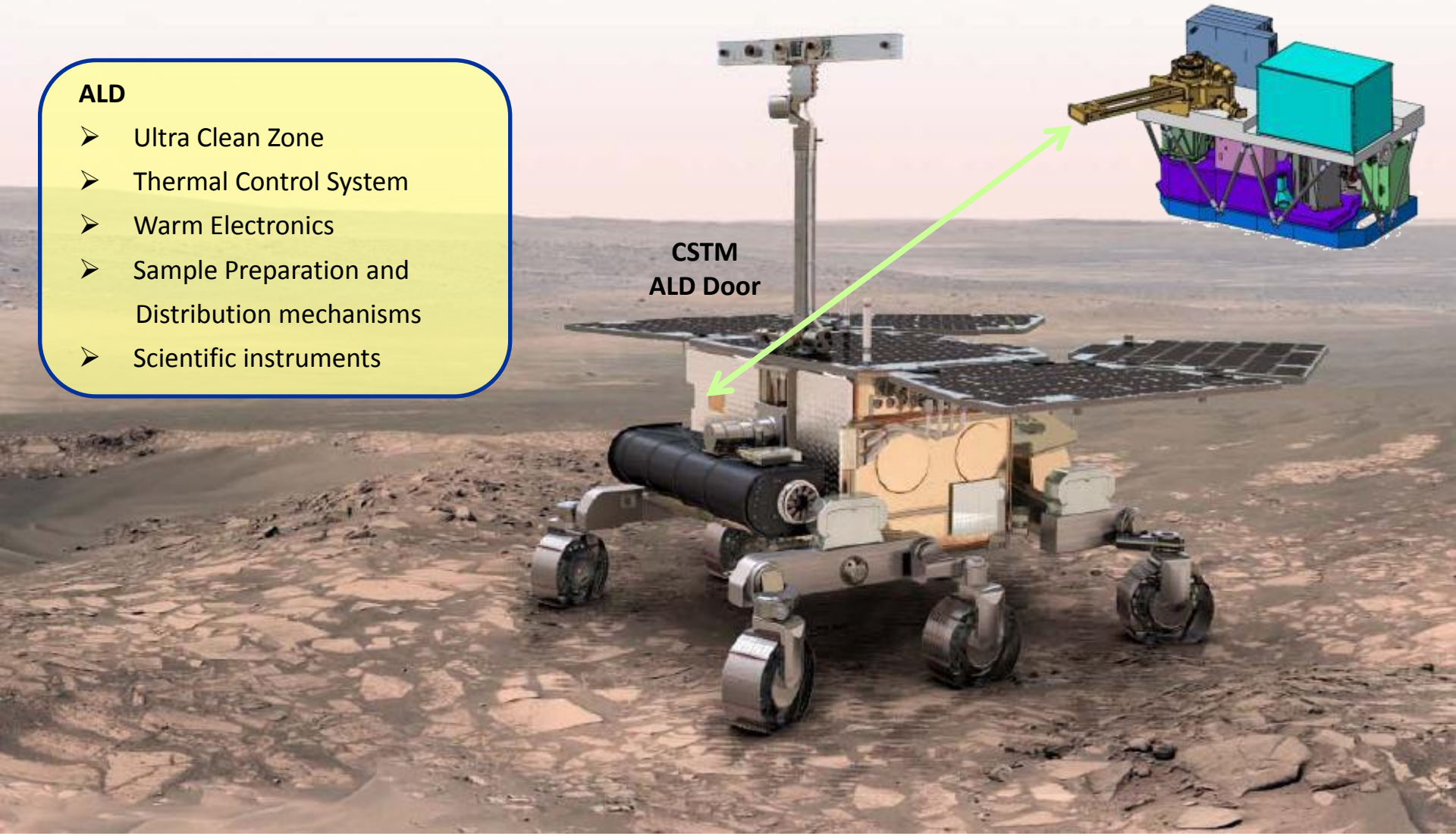


Ma_Miss

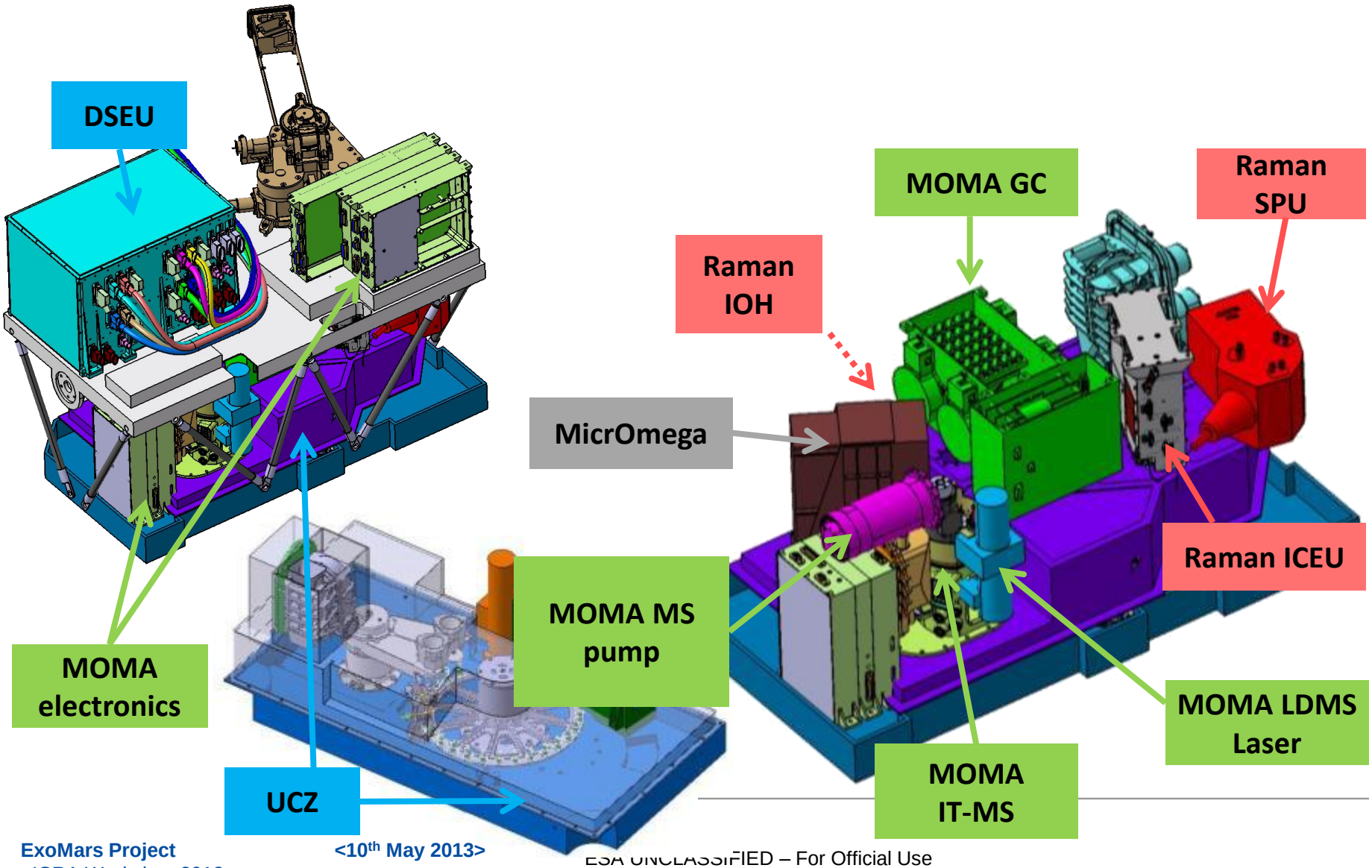
Rover Payload: Analytical Laboratory Drawer (ALD)

ALD

- Ultra Clean Zone
- Thermal Control System
- Warm Electronics
- Sample Preparation and Distribution mechanisms
- Scientific instruments



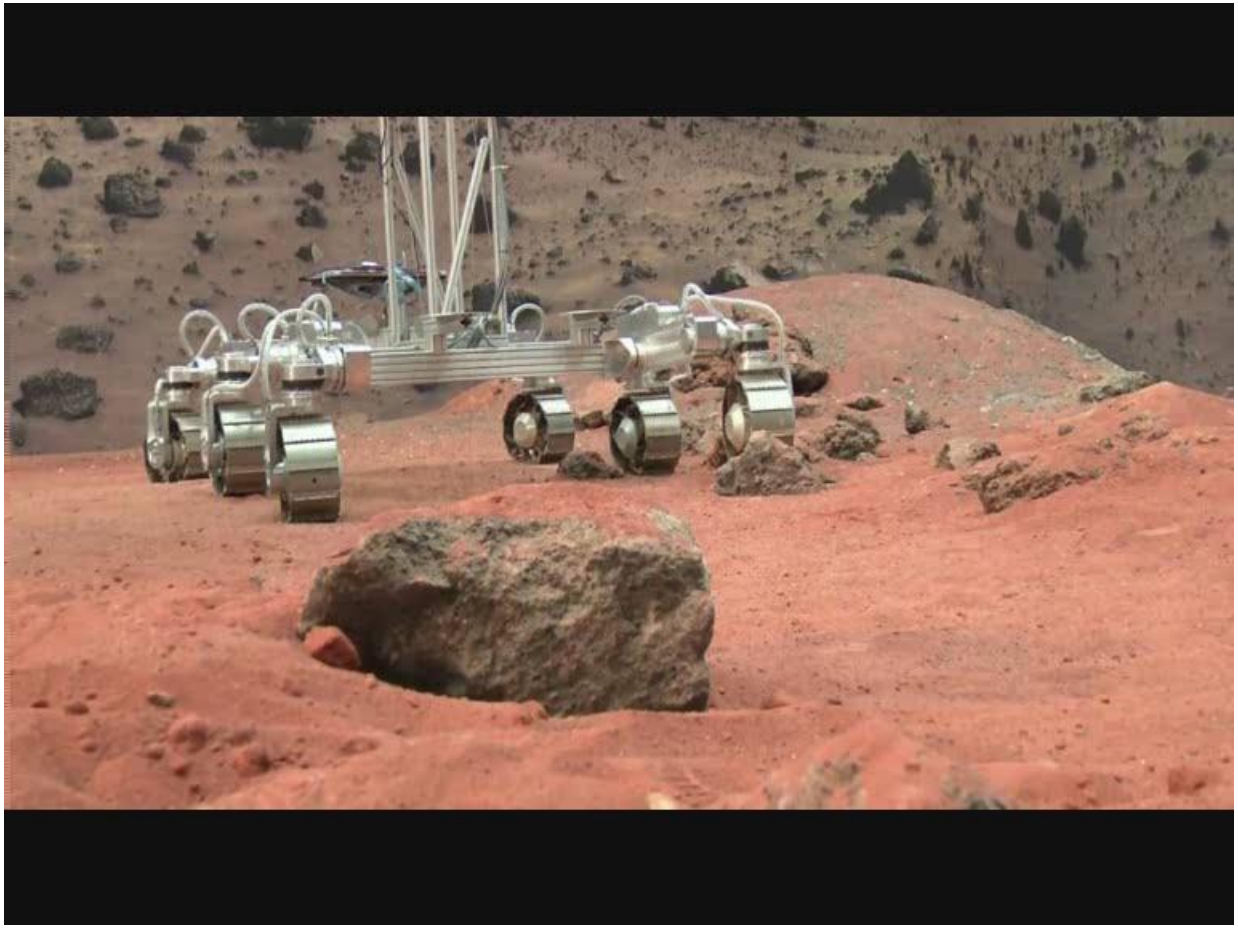
ALD instruments accommodation



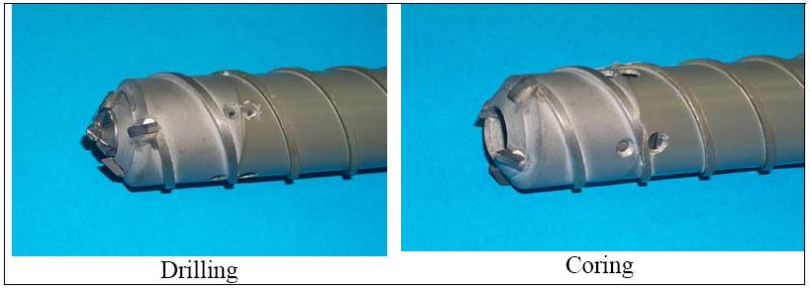
Rover Functionalities in support of Scientific Payload

- **Mobility System**
- **Drill**
- **Sample preparation & Distribution System (SPDS)**
- **Thermal Control System (TCS)**

Mobility System
Locomotion Breadboard Test

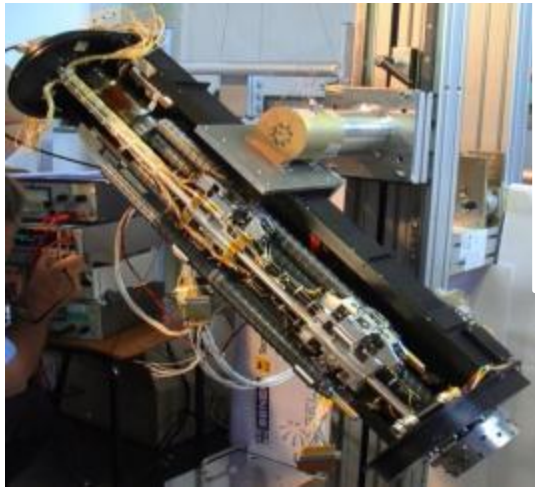


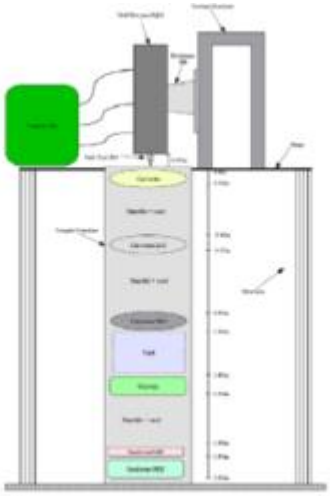
Drill Tool with Sample Acquisition & Discharge

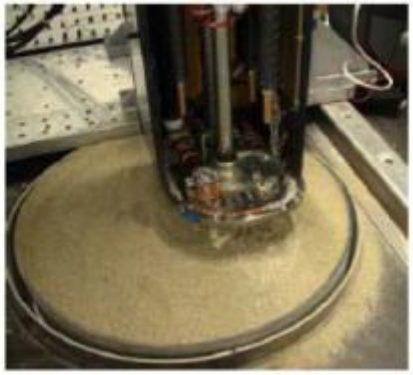


Drill Testing activities

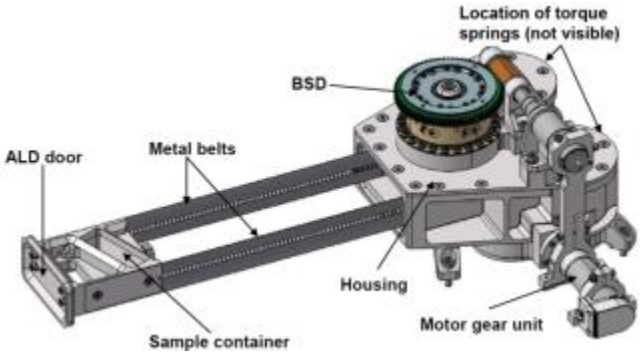
- **Completed Drill Tests**
  - Pre-EQM tests (down to 2 m) in Lab and Mars environmental conditions (last campaign in March 2013) and on Mars representative materials
  - Cold electronics validation test (FTS - completed & DBE – to be started)

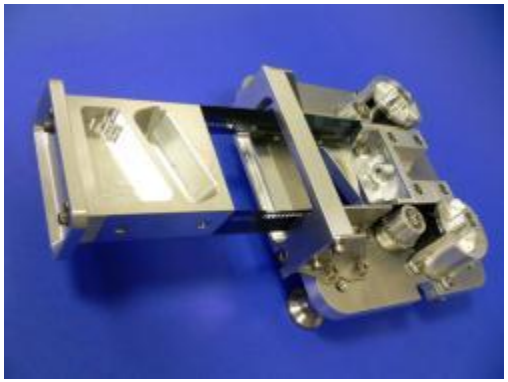


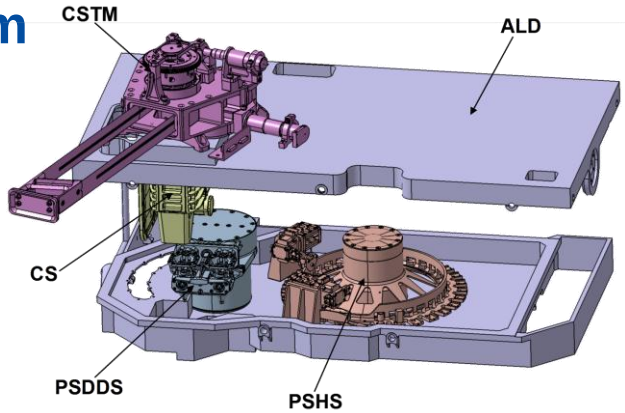




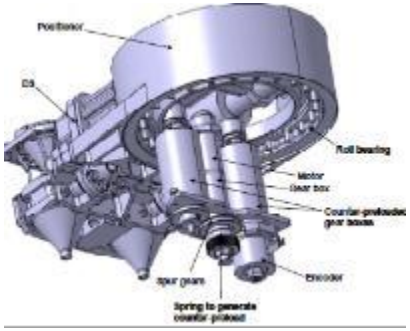
SPDS - Sample Preparation & Distribution System

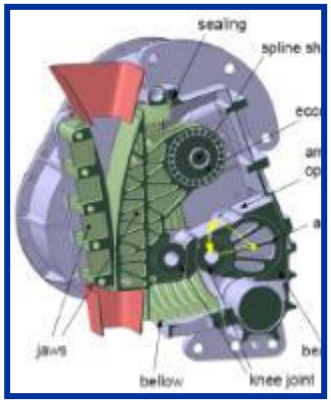




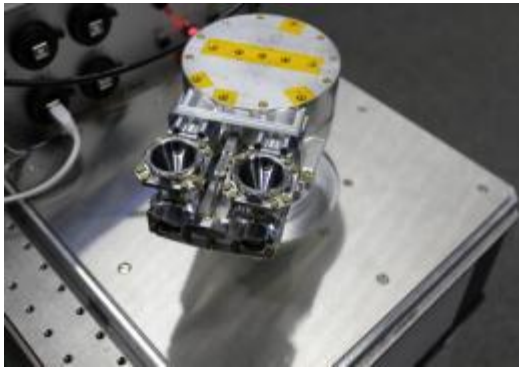


Core Sample Transport Mechanism (**CSTM**)
+ Blanks Dispenser (BSD)





Crushing Station (**CS**)
EM



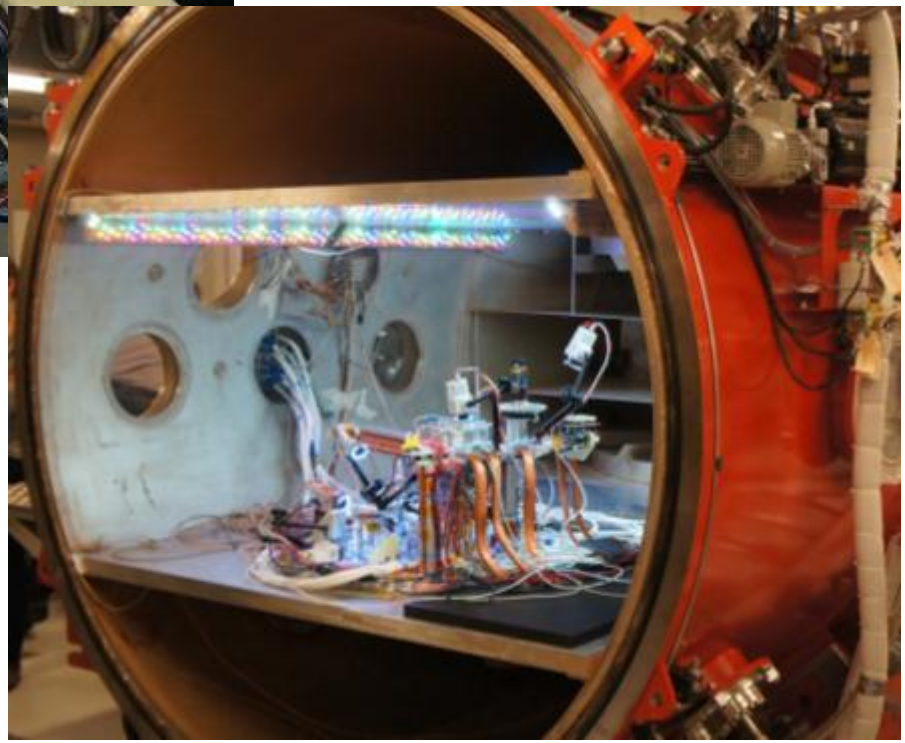
PSDDS: 2 Dosing stations + Positioner

PSHS + RC + FD + GC ovens

RC & FD

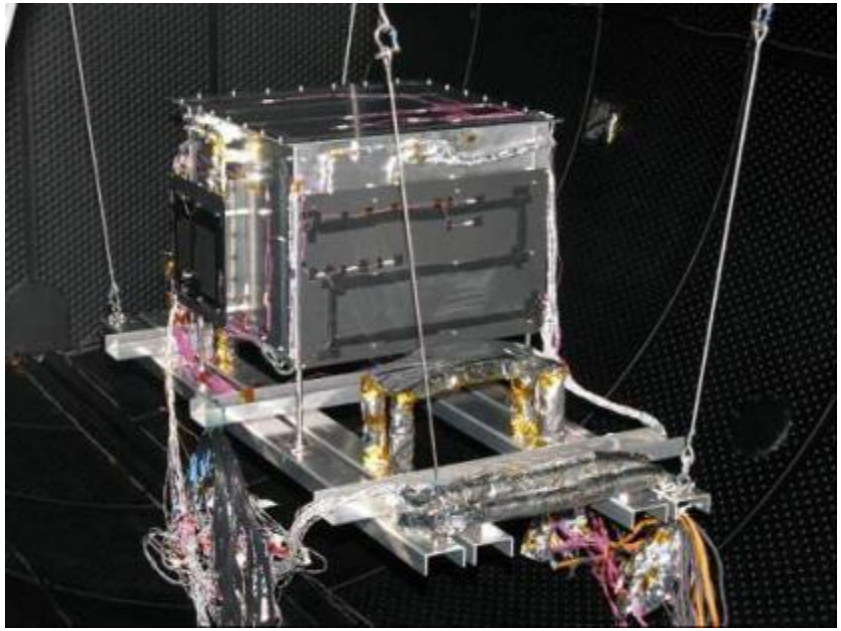
SPDS E2E Test in Lab and Mars Environment

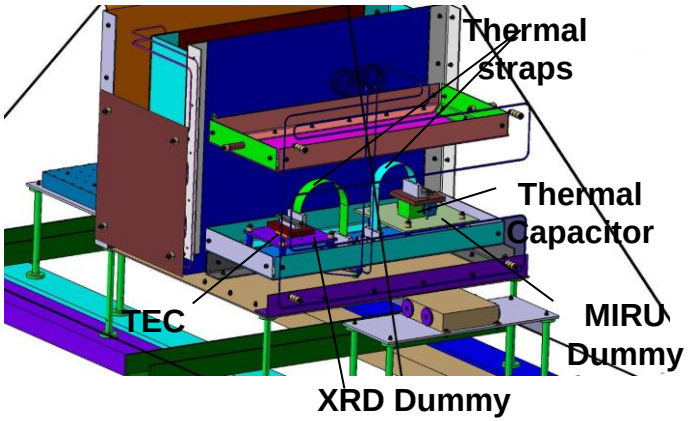
Test in Kayser-Threde (D)

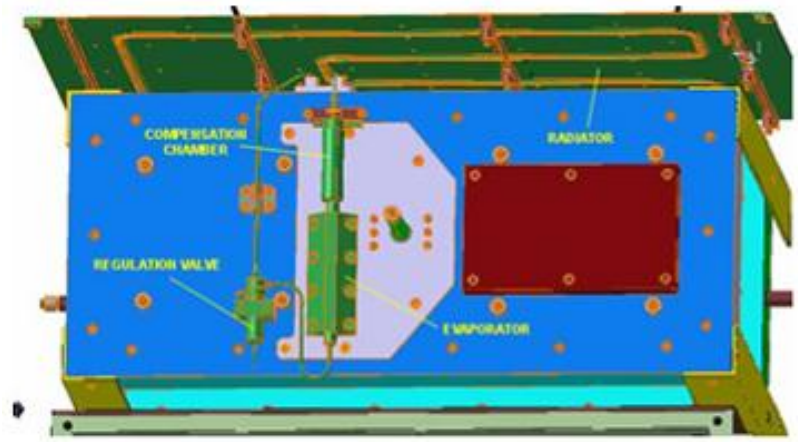


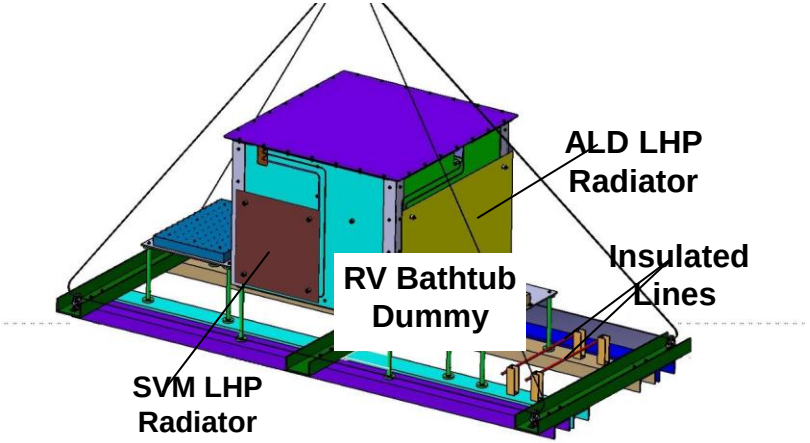
Test in Aarhus (DK)

TCS Loop Heat Pipes BB test







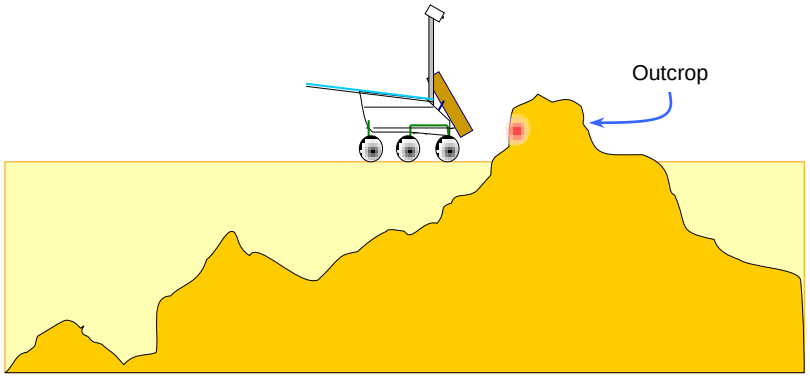


II - Rover Reference Surface Mission

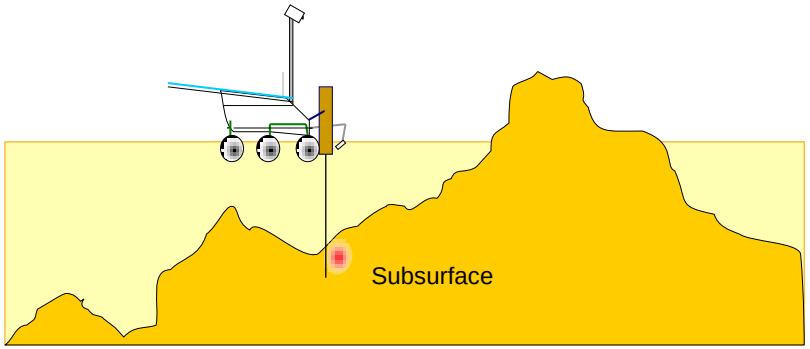
Reference Surface Mission

To complete 6 Experiment Cycles & 2 Vertical Surveys within 218 sols.

Experiment Cycle:
Include driving to a site selected for good science potential , drilling to acquire a sample preserved from radiations at least 1.5m below the surface. Process and analyse the sample with the SPDS and the full set of analytical instruments.

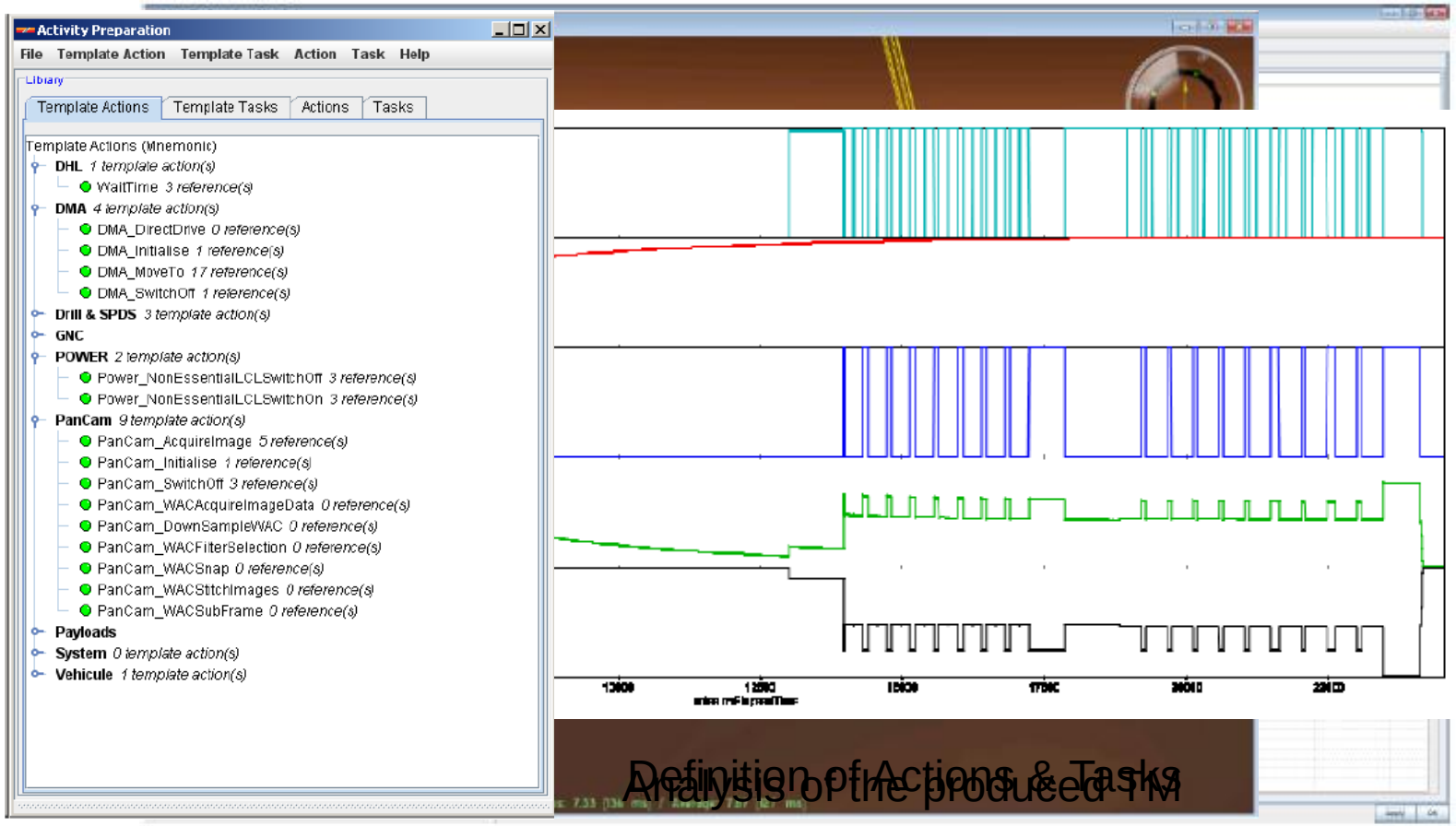


Vertical Survey:
Acquire & analyse a sample every 50 cm from 0m to - 2m below the surface.



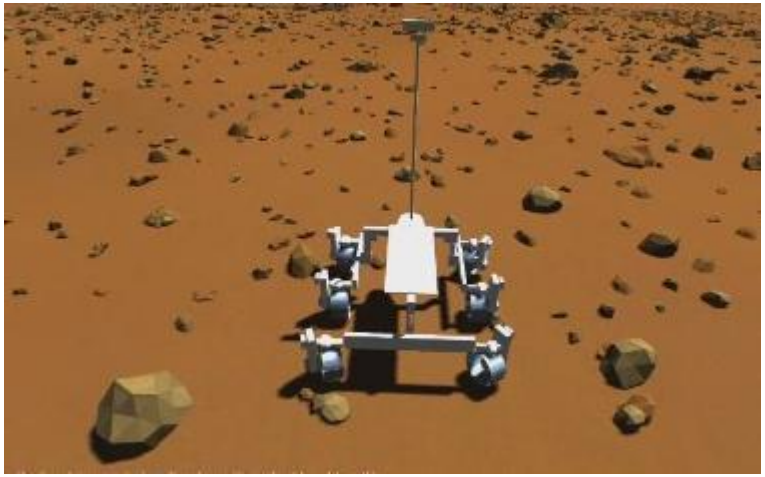
Tactical & Strategic Planning at ROCC

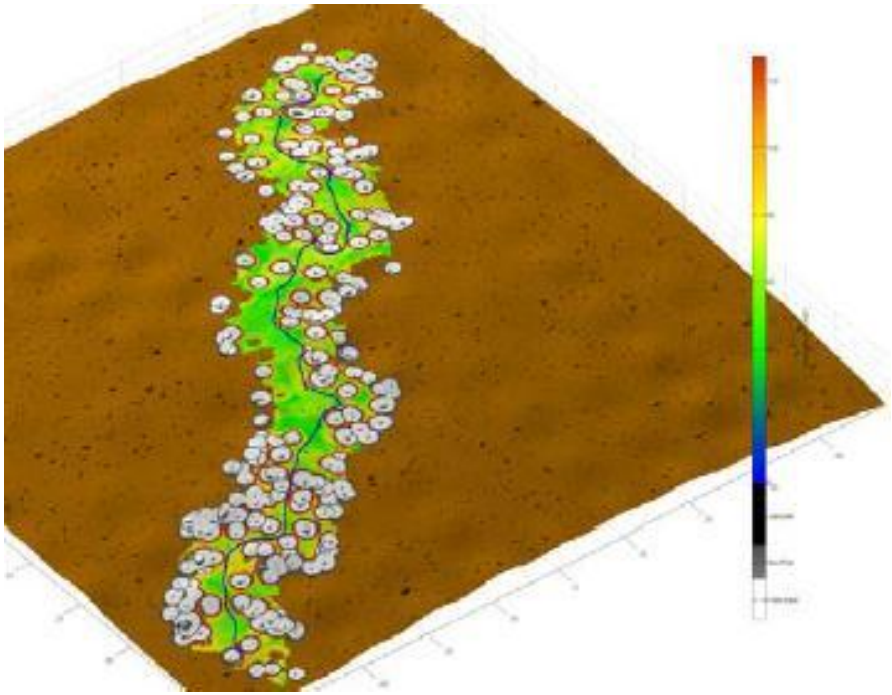
Based on TM received via TGO twice a day



Simulation execution with ROSEX (TAS-I)

1/ Rover drives autonomously to interesting scientific location

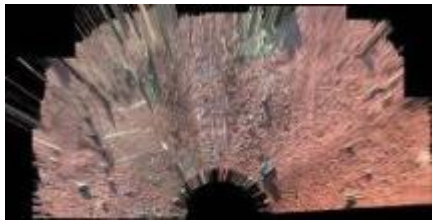




- About 100m along path per sol
- Use of WISDOM and ADRON for rough initial understanding of the subsurface characteristics

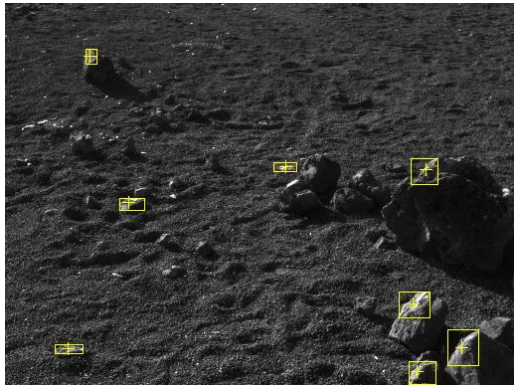
2/ Survey the site

Colour
Panorama
With PanCam WAC



DEM

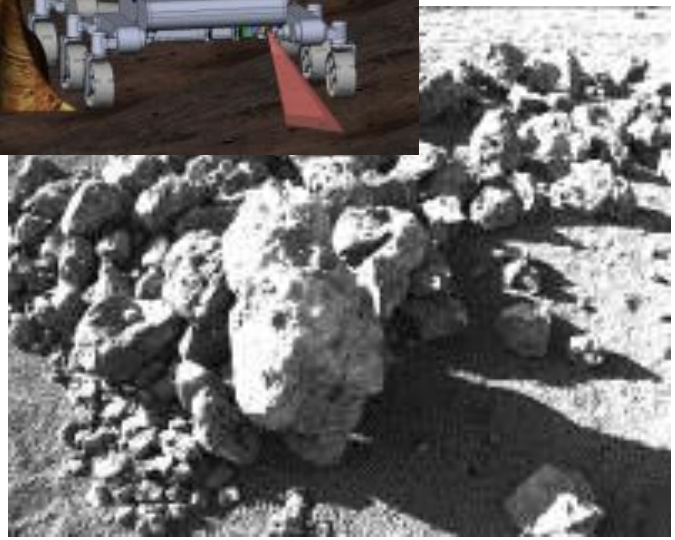
True colour / multispectral images



High resolution images
from PanCam HRC
with Infrared Spectra from ISEM

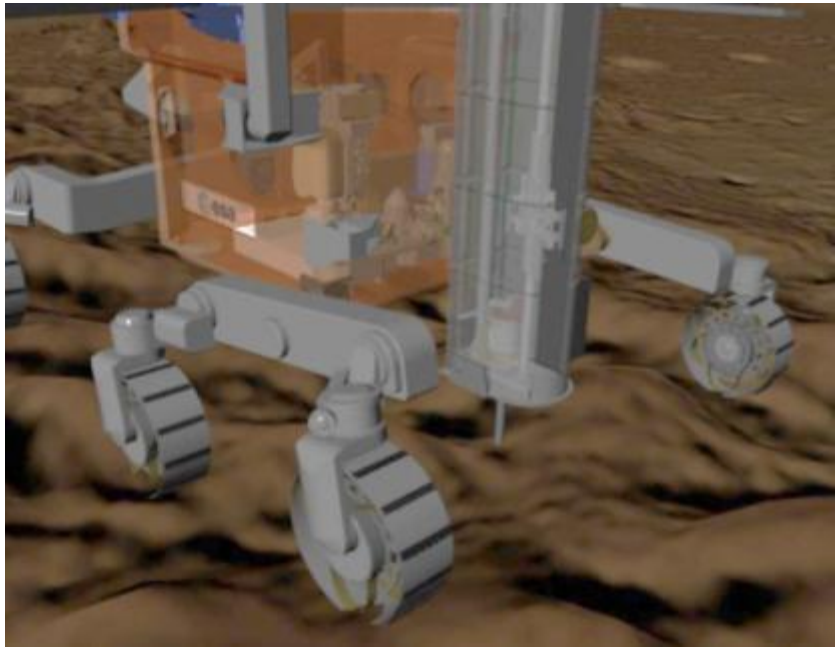
3/ Select and study an outcrop

- Rover moves closer to the target
- Use of CLUPI, HRC & ISEM



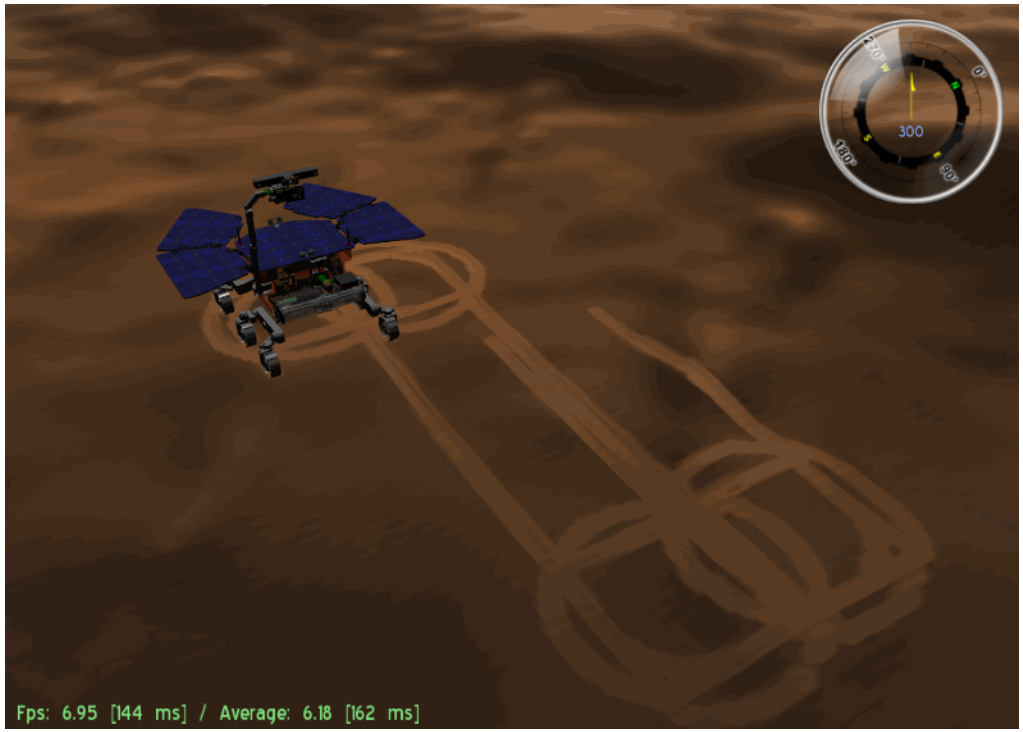
4/ Acquire and analyse surface sample

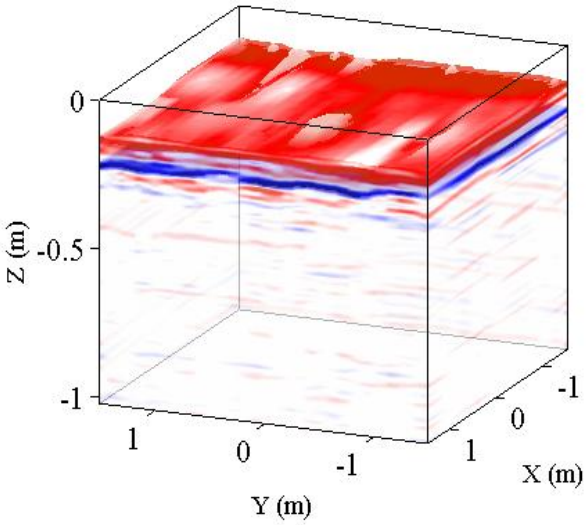
- Initial analysis with the suite of ALD instruments: Micromega, RLS, MOMA LD-MS & MOMA GC-MS



5/ Search for deep drill area

- Scanning of a ~5 x 5m area with WISDOM ground penetrating radar
- Use of WISDOM & ADRON to understand the subsurface water content





Subsurface 3D map

6/ Drill to defined location

- Use of Ma_Miss Infrared Spectrometer for in-situ spectroscopic analysis
- Acquisition of the target at a defined depth
- Use of CLUPI to image drill fines
- Use of CLUPI & HRC to image the sample core after discharge

Note: Movies are accelerated

7/ Sample processing in the ALD

8/ Crushed sample analysis in the ALD (Ultra Clean Zone)

- **Detailed analysis with the suite of ALD instruments**

  - MicrOmega : Hyperspectral Microscope shall characterize the structure and composition (molecular and mineralogical) of each sample
  - RLS : Shall provide Raman Spectra for multiple areas selected by MicrOmega
  - MOMA LD-MS : laser desorption – mass spectrometer output
  - MOMA GC-MS : Gas Chromatograph – mass spectrometer output (use of an oven on the carousel of the SPDS).

III - Rover Development Status

Rover design and development progress 1/3

- **2018 Mission study running under phase B**
  - System SRR Q2 2013
  - System PDR Q1 2014

- **Rover development activity continue with Adv. CD funding**
  - Rover System PDR passed in Dec. 2010
  - Rover top level specifications updated to reflect latest mission architecture and scenarios adjustments
  - **Rover Vehicle PDR and ALD PDR are planned in Q2 2013**
    - Instruments and subsystems PDR (SPDS, DSEU, RV elements) will follow
    - Design of SPDS EQM to be started immediately

- **SPDS EQM MAIT to be completed by Q4 2014**

- **ALD EQM I&T scheduled in Q2 2015**

Rover design and development progress 2/3

- **Rover Vehicle equipment procurement has been resumed and is in progress; the following contracts have been or are being negotiated:**

  - Bogie Electro Mechanical Actuators (BEMA)
  - Actuators Drive Electronics (ADE)
  - Navigation/Localization Cameras (NavCams)
  - RV Structures
  - On Board Computer (OBC)
  - Power Control & Distribution Electronics (PCDE)

ITTs issued or in preparation:

  - IMU & sun sensor
  - Deployable Mast Assembly
  - Hold Down Release Mechanisms & Umbilical
  - Battery
  - SCOEs
  - Solar Arrays Assemblies

Rover design and development progress 3/3

- **Rover technology developments continue:**
  - Mobility and GNC development & validation tests on going at ASU Mars Yard with Rover Breadboard
  - Loop Heat Pipes additional test planned in 2013
  - Drill pre-EQM test in Mars like environment (including Ma_Miss) completed in March 2013 (2 m depth)
  - Sample Processing and Distribution System (SPDS) Engineering Models and Elegant Breadboards assembly & stand-alone tests completed in 2012
  - SPDS End-To-End Test campaign in Mars like conditions (Aarhus facility-DK) completed in March 2013

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The Drill system is developed by Selex Galileo – Italy;
The SPDS is developed by Kayser-Threde – Germany;
The ROCC is developed by ALTEC - Italy.
The instruments are individually funded by national space agencies.

QUESTIONS ?