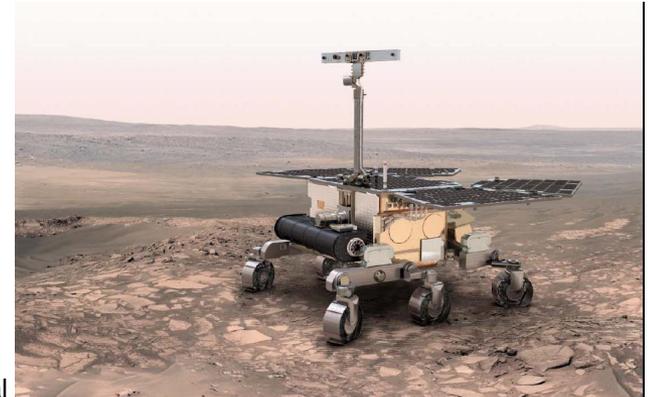
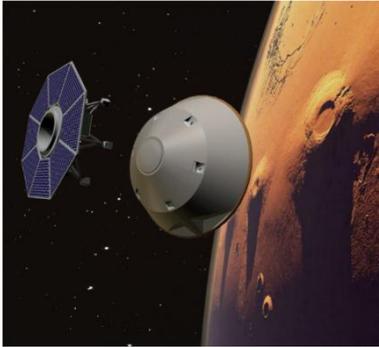


EXOMARS PROJECT 2018 Mission

Rover development status

ASTRA Workshop 15-17 May 2013

P. Baglioni & the EXM Rover Team

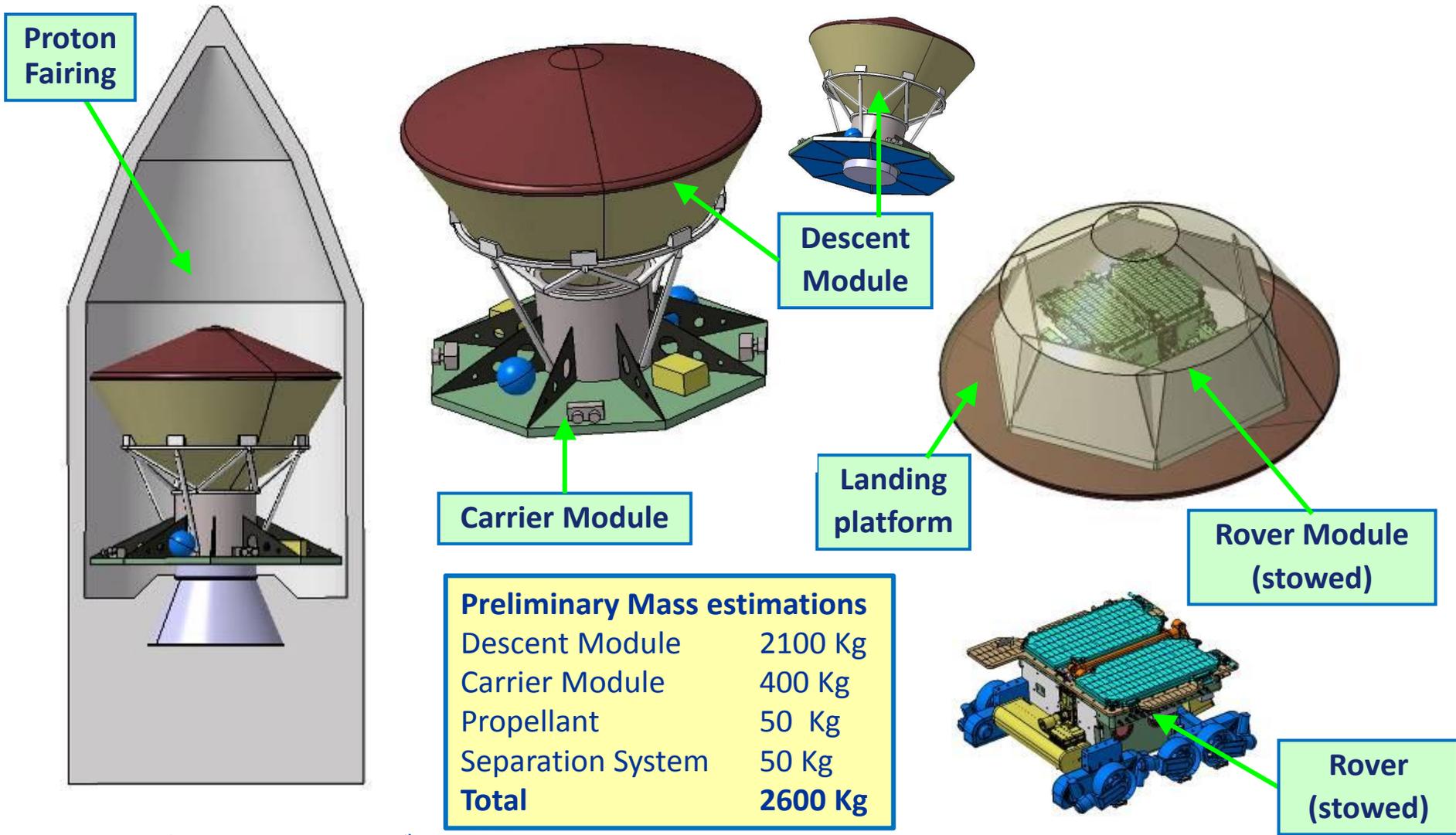


Progress on the 2018 Mission

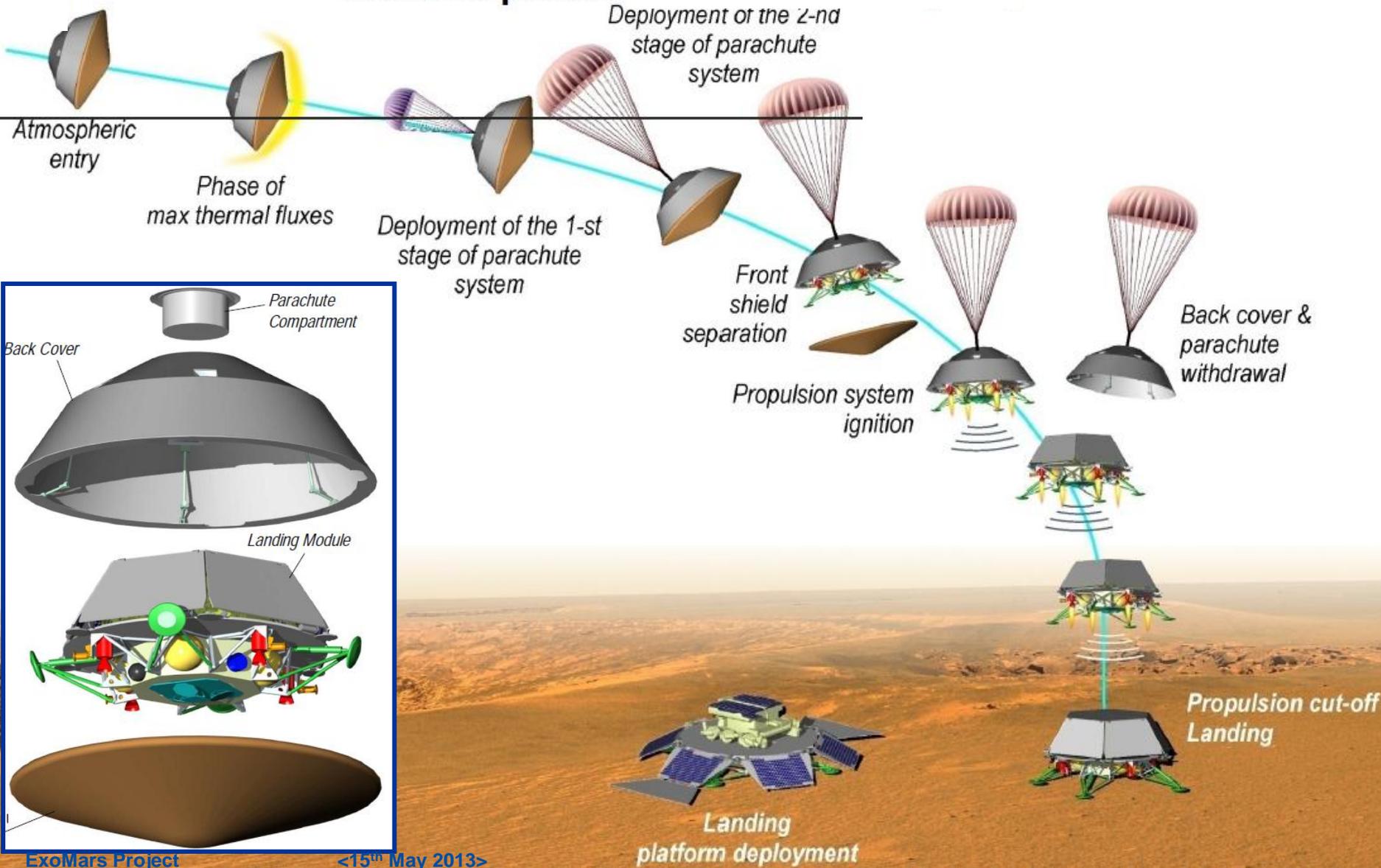
- **Following EXM Program approvals from the Council and IPC in 2012, the 2018 Mission Phase B has been kicked off with European and Russian Industry in December 2012**
 - Lavochnik (Ru) is developing concepts for the Descent Module and its Landing Platform, using the existing Rover design as driving requirement
 - The Rover Team is involved for the definition and consolidation of the Rover-Lander interfaces (RM to DM IRD & Env. Specs)
- **An SRR - System Requirements Review (Agency Level) is foreseen in Q2 2013**
- **An S-PDR System-Preliminary Design Review (Agency Level) is foreseen in the Q1/2 of 2014**

Roscosmos and Russian Industry will fully participate to both reviews

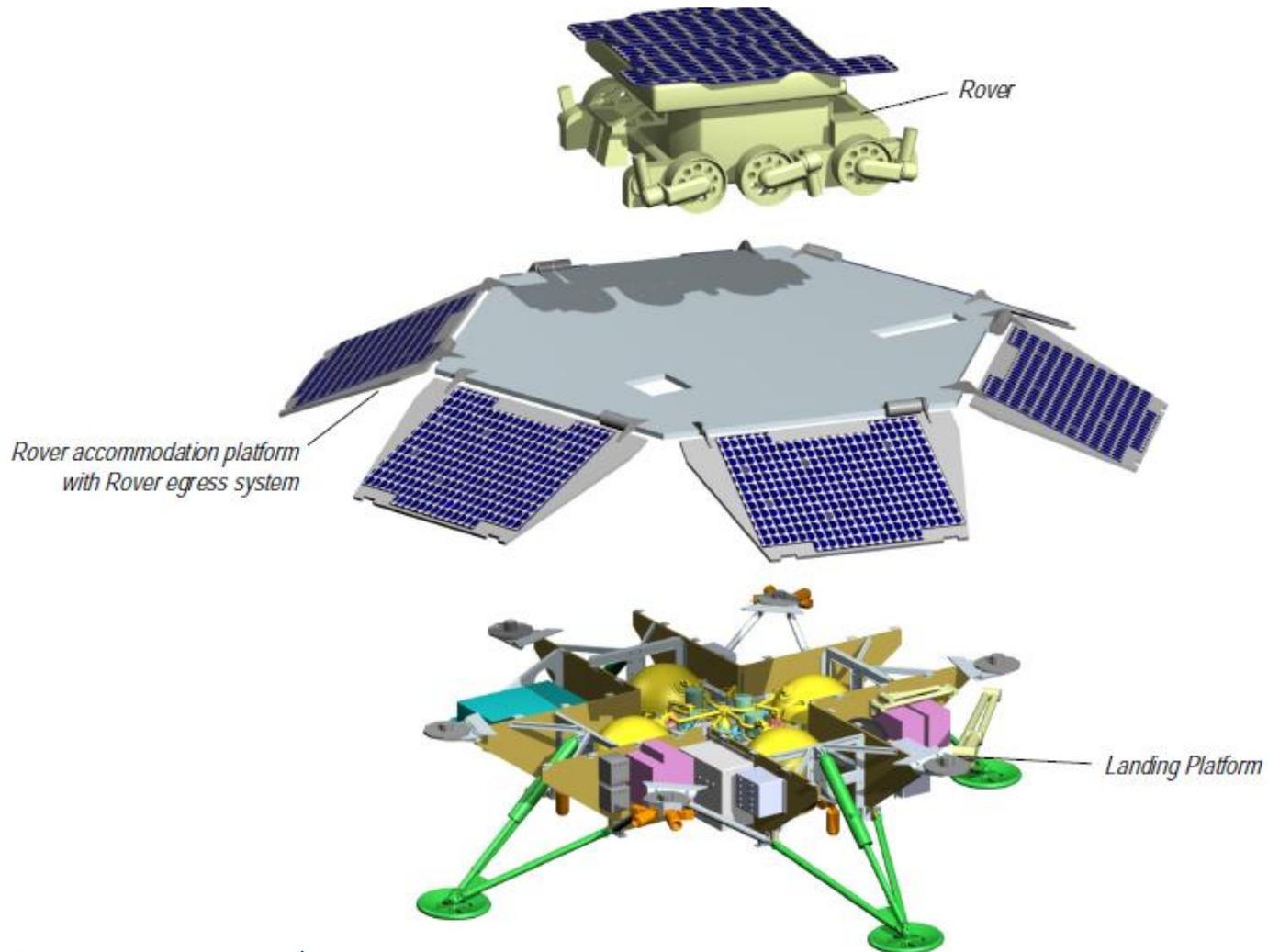
2018 Mission architecture



Descent profile

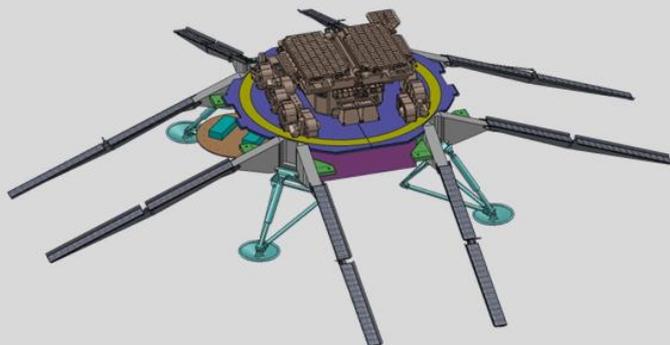


Landing Platform concept

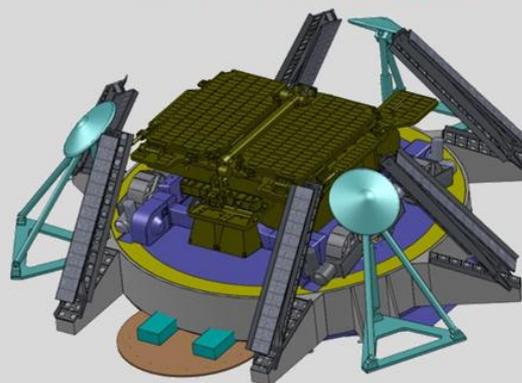


Other options under evaluation (Lavochkin)

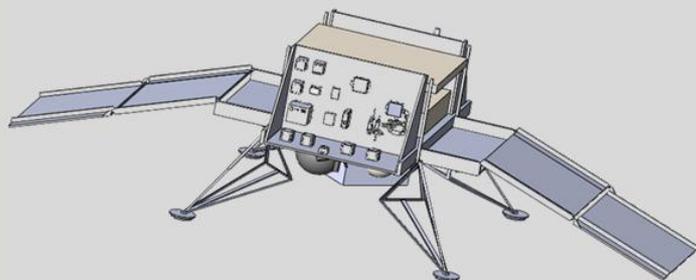
Option 1.
4 directions – 4 landing gears



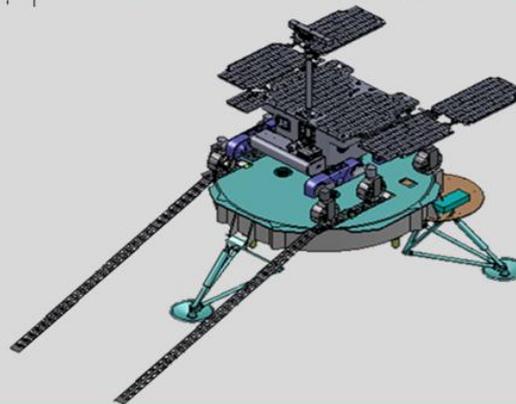
Option 2.
3 directions – 3 landing gears



Option 3.
2 directions – 4 landing gears



Option 4.
1 direction – 3(4) landing gears



Deployment & Egress main sequence

From Landing to Rover SA partial deployment
Nominal

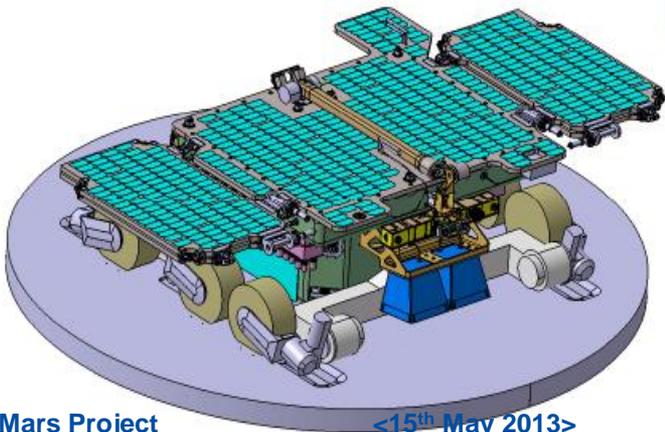
It is necessary to quickly partially deploy the Rover Solar Panel because the Rover can not live only with the battery support. The battery is necessary to survive during the night

Release of SA hold-down

NOMINAL OPERATING SEQUENCE

Rover Solar Array Deployment
– first part

Go-Ahead from Ground to execute the first Rover Module checkout on Mars



From Initial Functional Checkout to Rover Stand - Up

Rover Module initial Functional Checkout on top of the Lander (focused on RV+PPL elements necessary to support the Rover Egress)

Images Acquisition

Release of Mast Hold Down

Mast deployment and panorama images acquisition

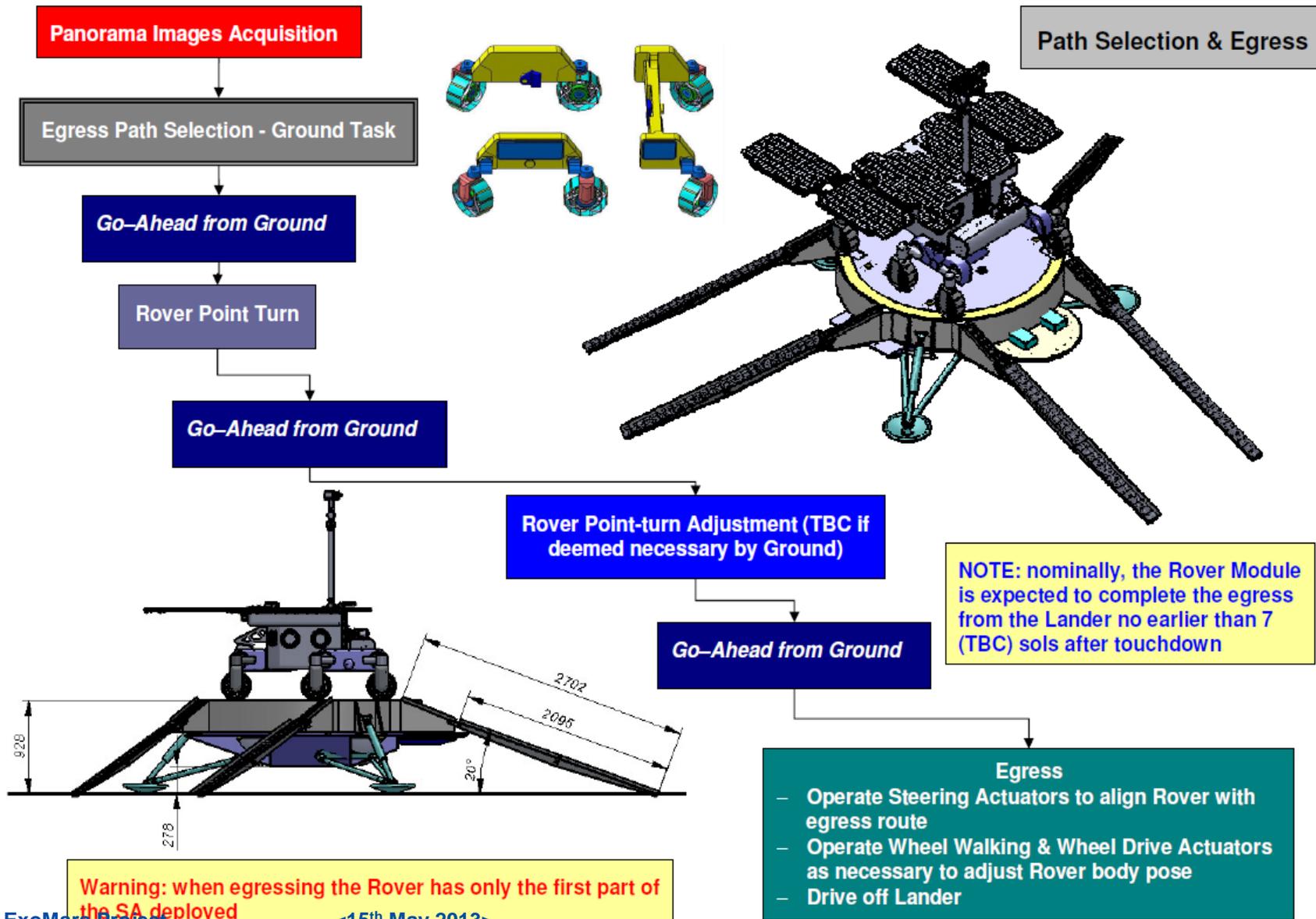
Rover Body Hold-Down Release

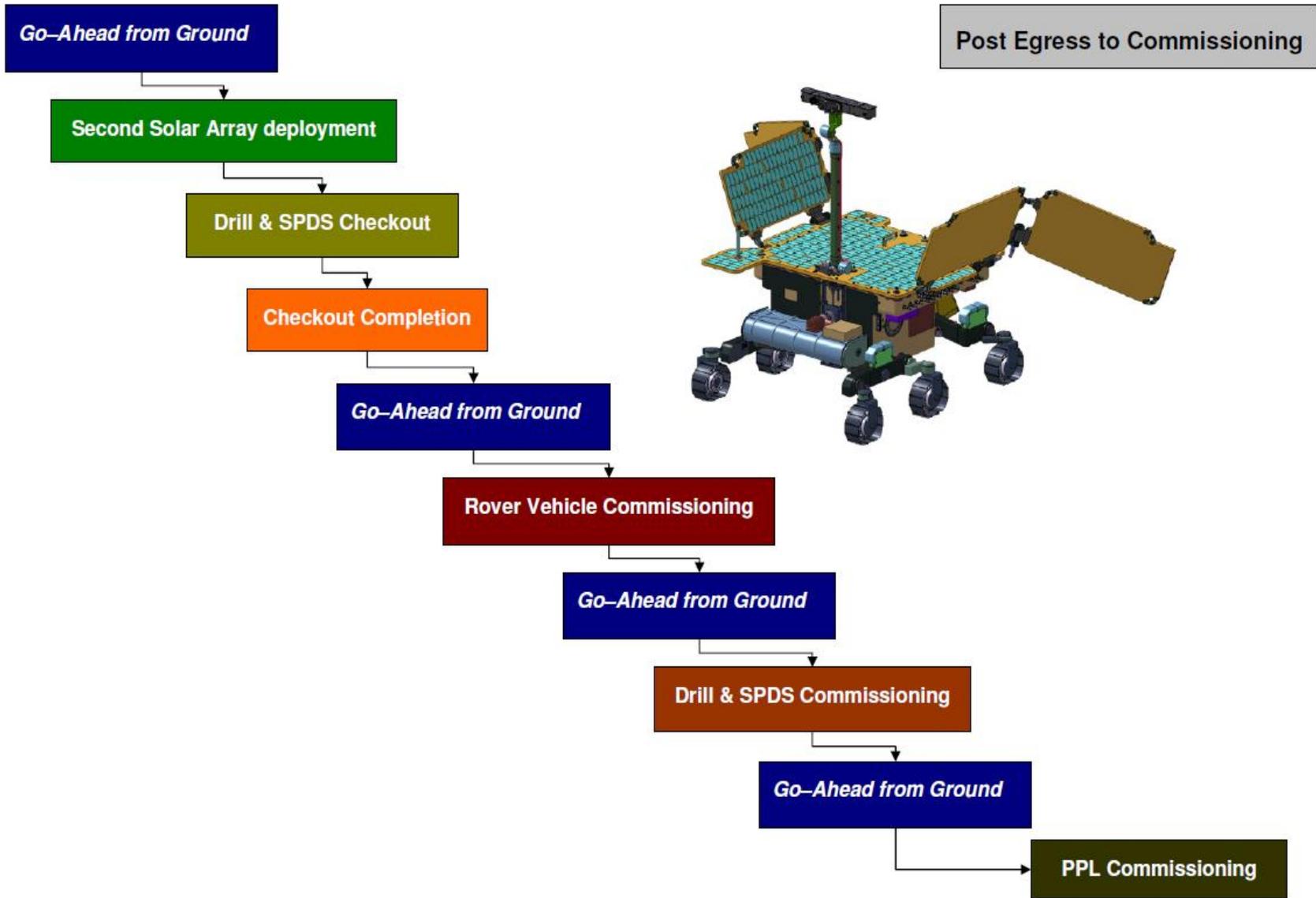
Wheel Hold-Down Release

Locomotion Subsystems Deployment

Rover Stand-Up and Umbilical Separation





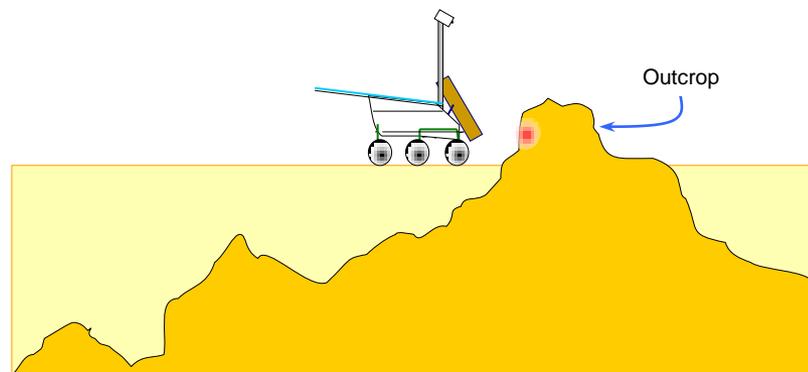


Reference Surface Mission

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

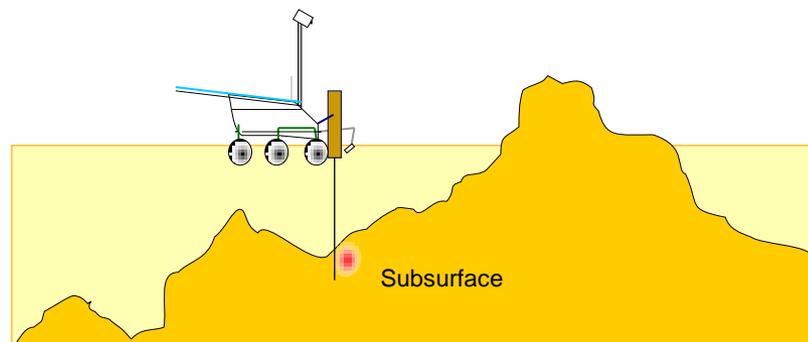
Experiment Cycle:

Include driving to an 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.



EC timelines and energy considerations

- ❑ **Nominal surface ops are supported in the latitude range 5S to 25 N**

- ❑ **The most demanding activities in terms of power/energy are:**
 - Traverse
 - Drilling
 - Laboratory analysis (ALD)

- ❑ **The first two operations had been up to now the most energy demanding:**
 - Travelling to reach a target at 70 m while performing GPR with Wisdom require about 1300 Wh/sol (figure inclusive of 20 % system margin)
 - Drilling required energy is largely dependant on subsurface material composition and hardness (ranges between 800 Wh to 1400 Wh)
- >> **Restrictions to max travelling distance/drilling time may apply, depending on Latitude/Ls**

- ❑ **ALD operations have reached the same (up to 1300Wh) level due to large increase of power demands from the MOMA instrument.**
- >> **Possibilities to split ADL activities to more sols.**

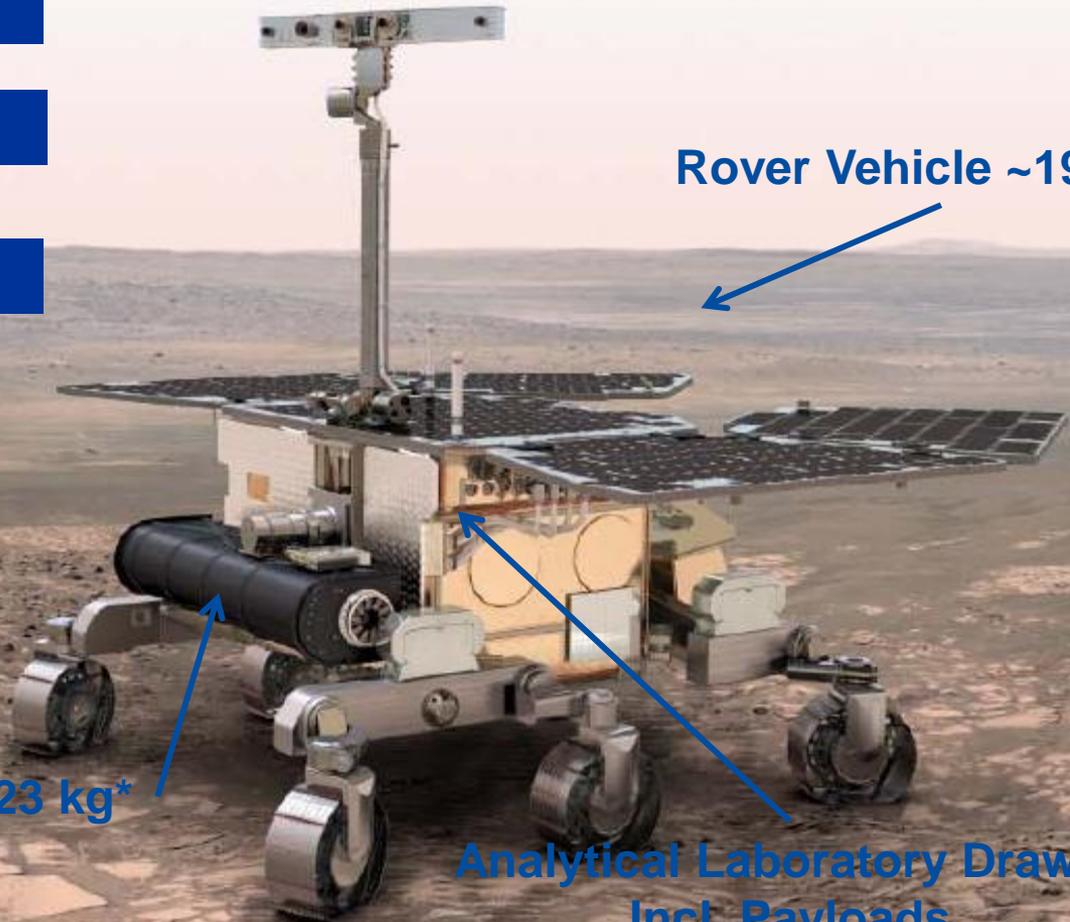
The ExoMars Rover

Rover mobile mass: # 310 kg

Science Payload mass: # 26 kg

Nominal Mission: # 218 sols

Latitude: 5 S – 25 N



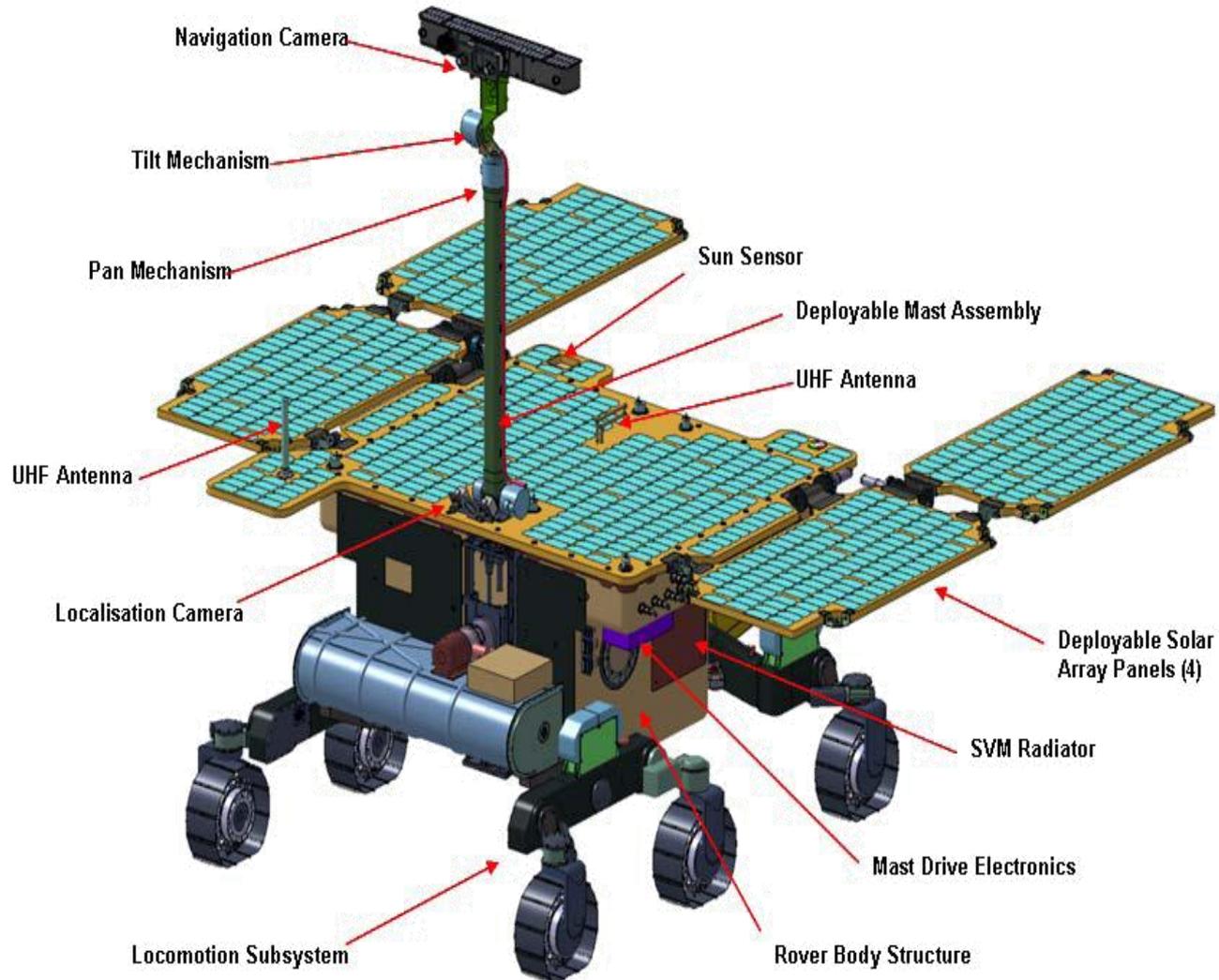
Rover Vehicle ~193 kg*

Drill System ~23 kg*

Analytical Laboratory Drawer
Incl. Payloads
~55 kg*

(*) excl. System Margin

Rover deployed configuration



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)*)

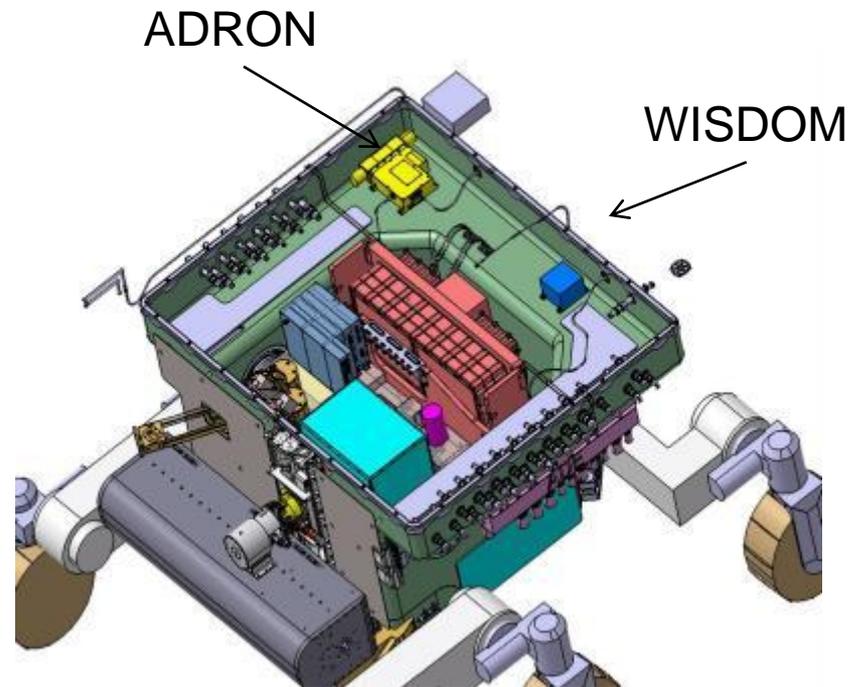
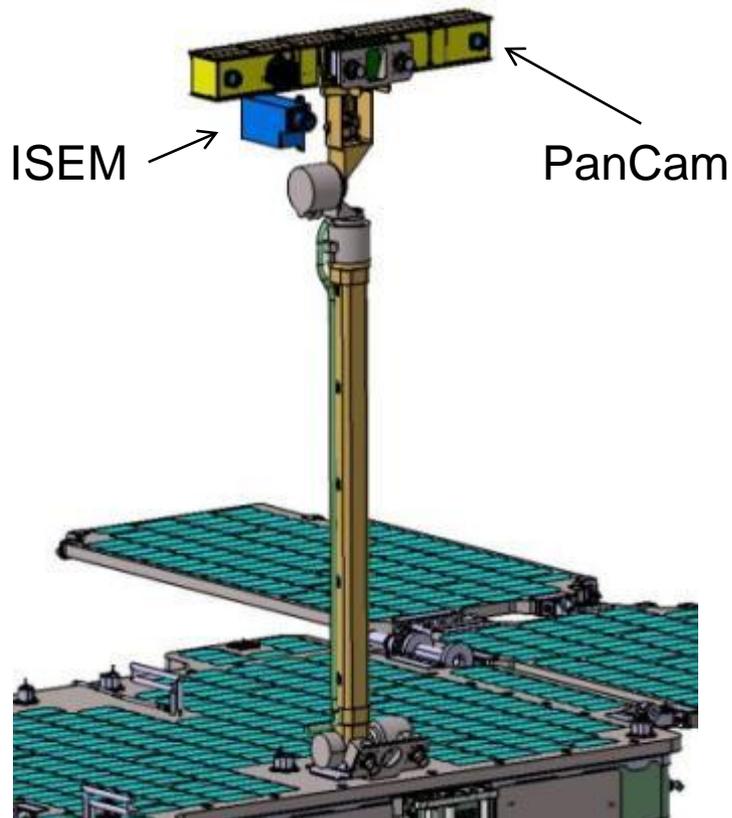
- **Mounted on the Drill**

- Ma_Miss (Mars Multispectral Imager for Sub-surface Science): wide-range infrared spectrometer to conduct mineralogical investigations.
- CLUPI: Close Up Imager

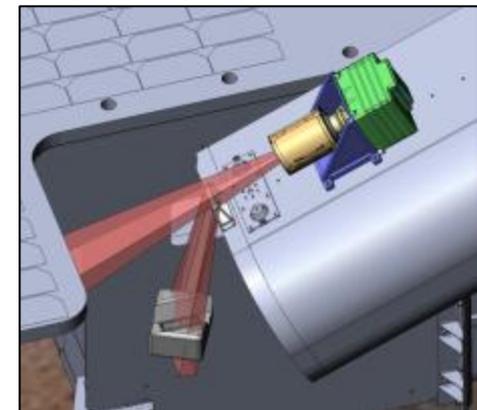
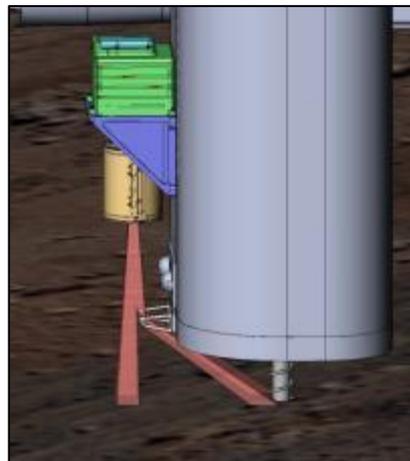
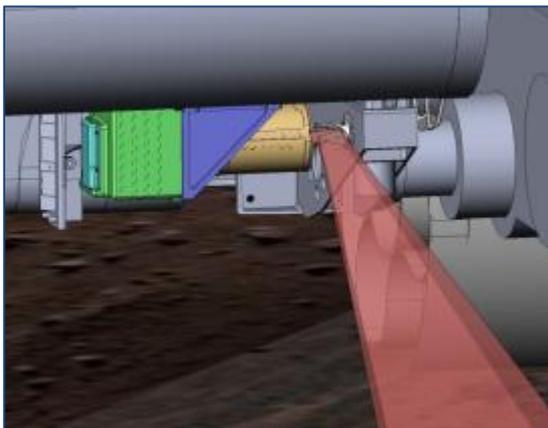
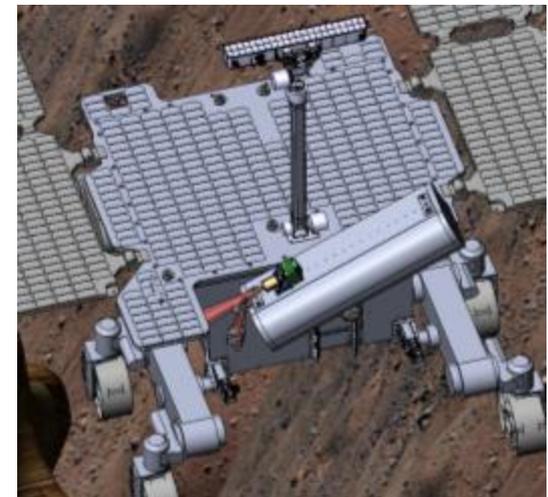
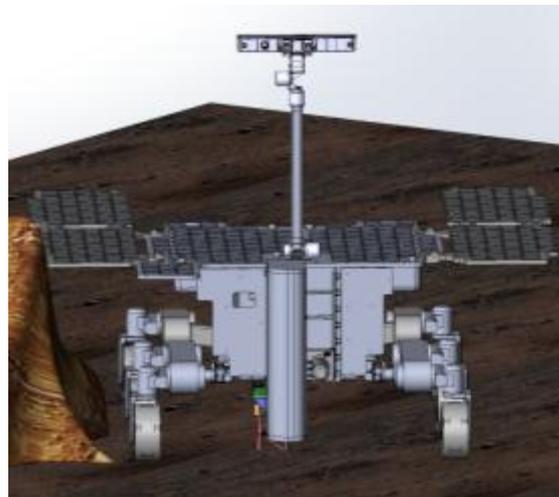
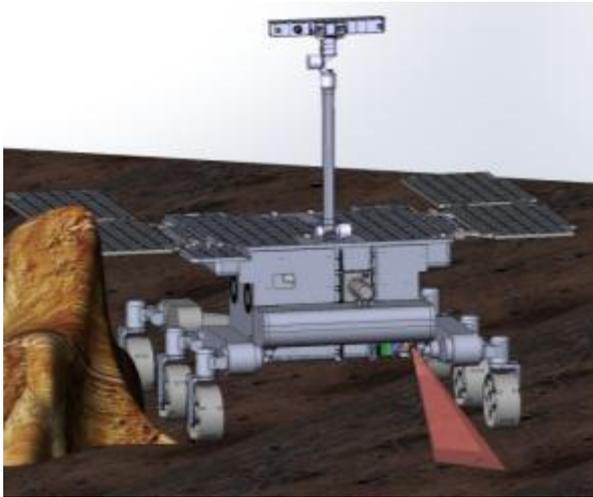
- **Mounted inside the ALD**

- 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



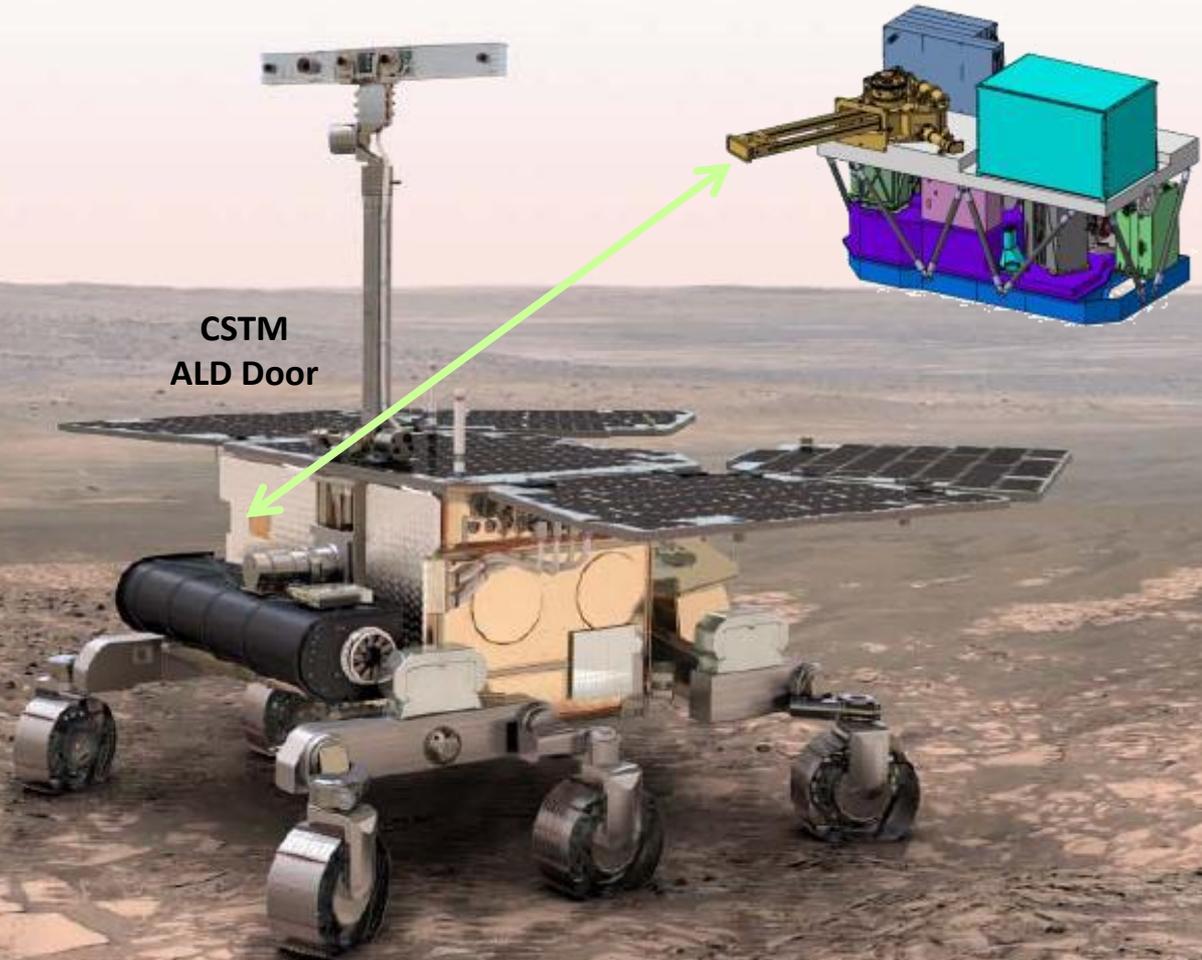
Ma_Miss



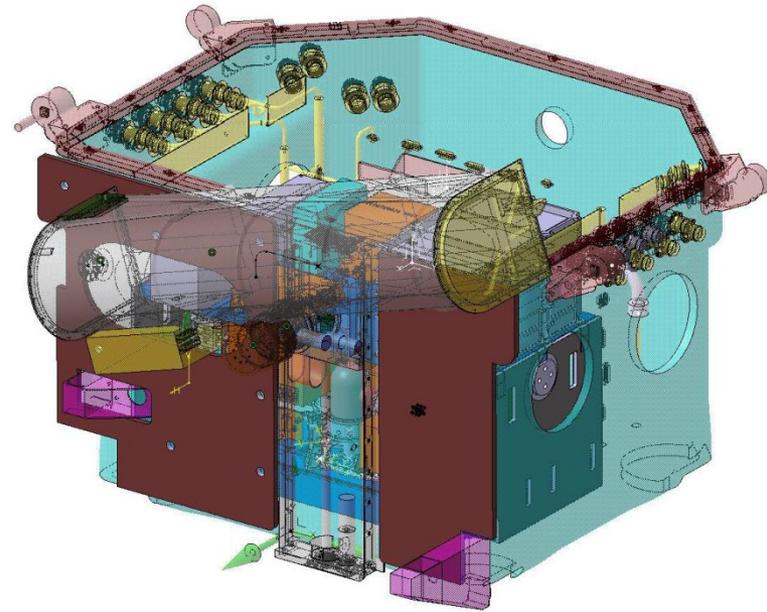
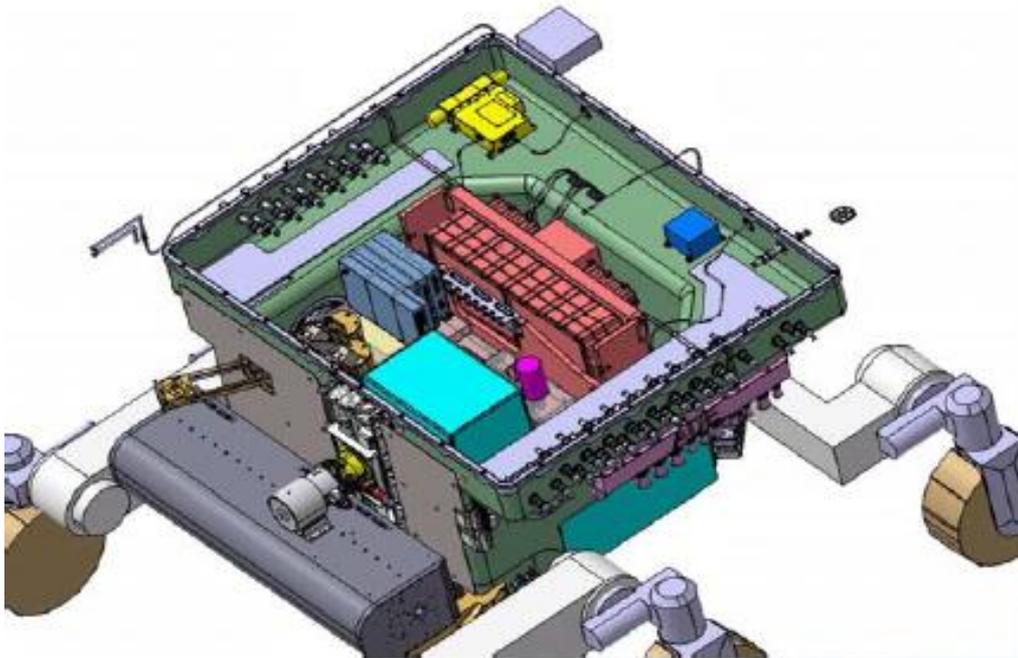
Rover Payload: Analytical Laboratory Drawer (ALD)

ALD

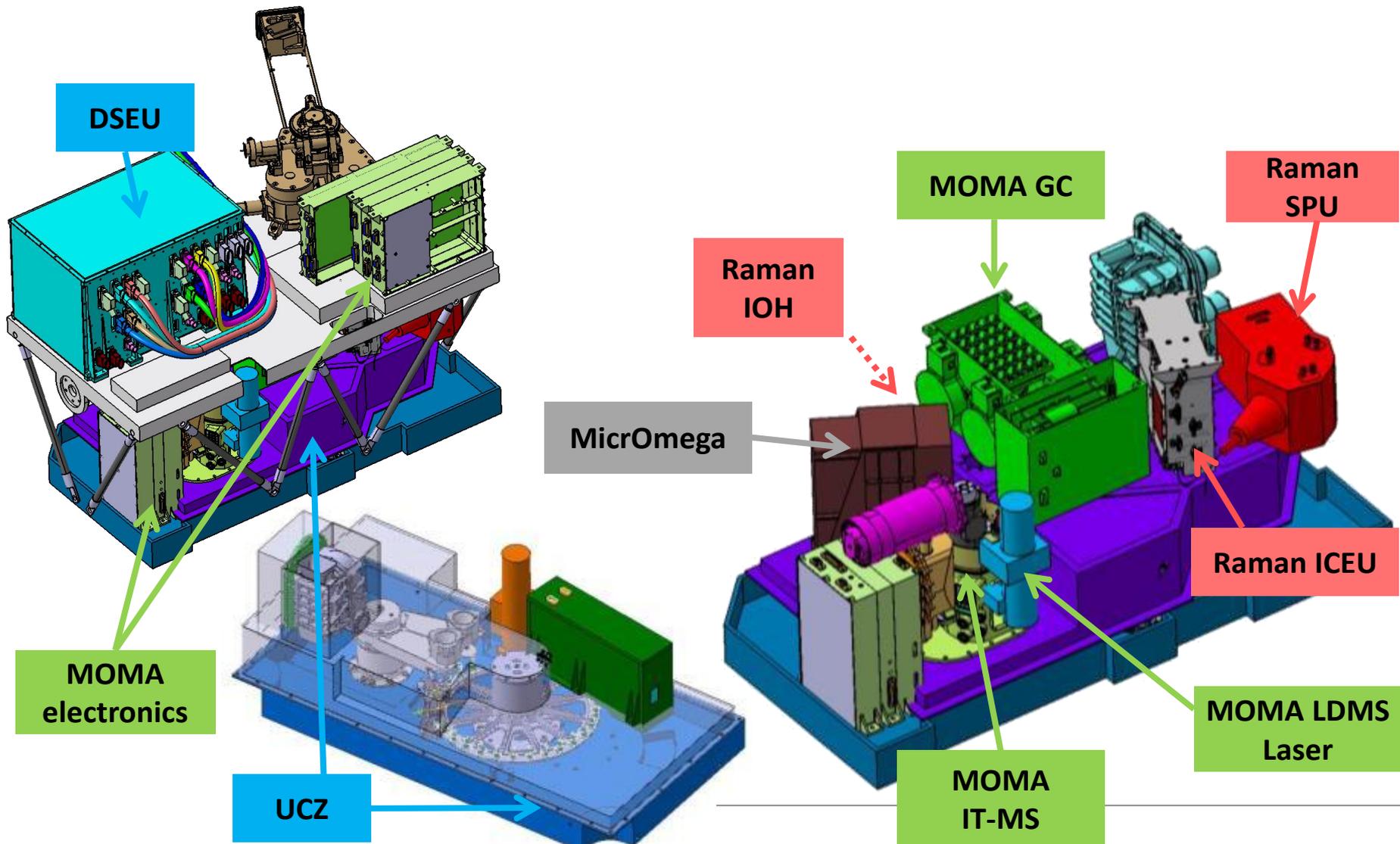
- Ultra Clean Zone
- Thermal Control System
- Warm Electronics
- Sample Preparation and Distribution mechanisms
- Scientific instruments



ALD accommodation in the Rover “bathtub”



ALD instruments accommodation

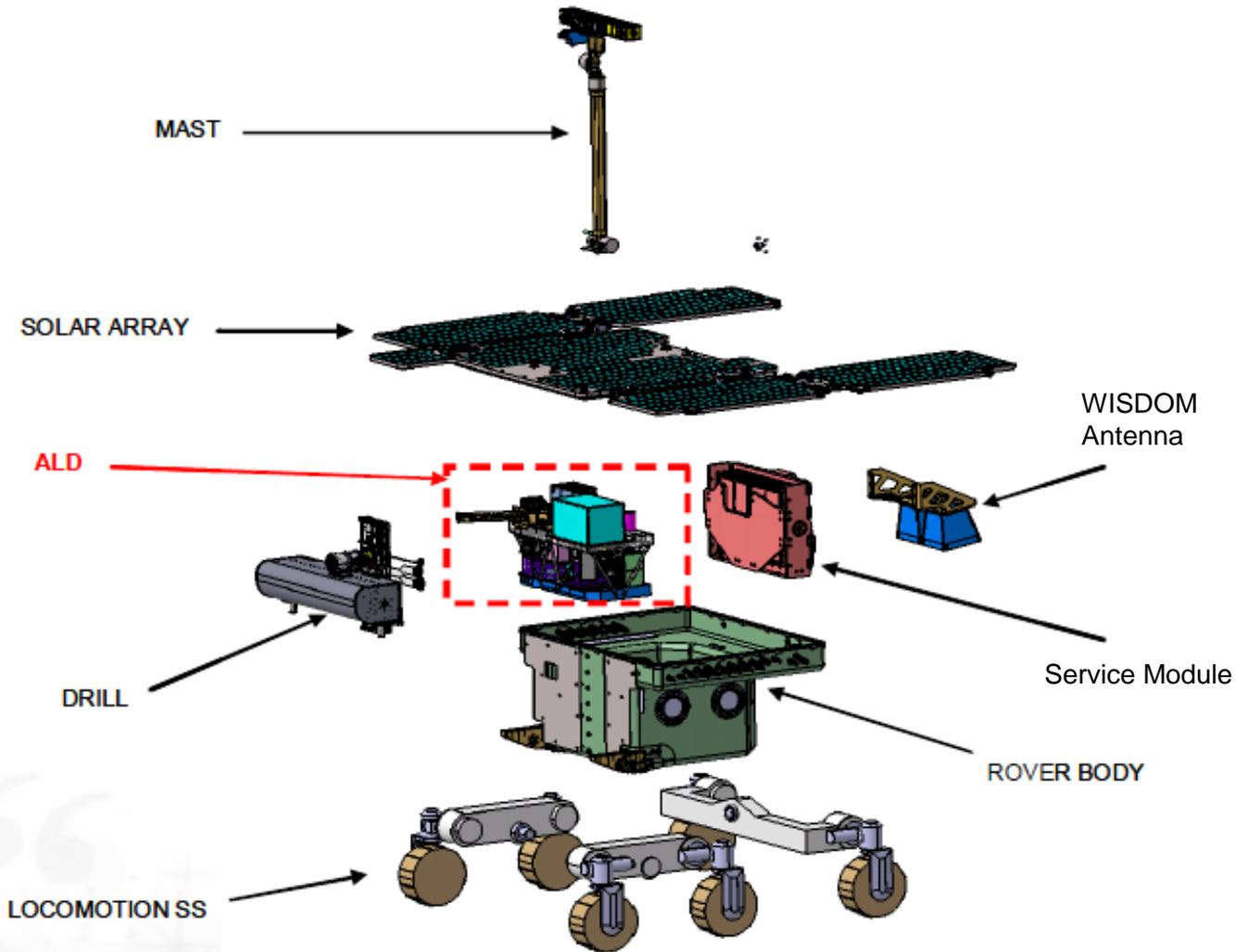


Rover design and development progress

1/3

- **Rover development activity continue with Adv. CD funding**
 - Rover System PDR passed in Dec. 2010
 - PDR Configuration reconsidered in 2012 in the frame of ESA-ROS cooperation
 - Rover scientific payload complement updated and modified in mid 2012
 - ALD payload reduction due to increase of requested resources
 - 2 new Russian Instruments
 - Rover top level specifications updated to reflect latest mission architecture and scenarios adjustments:
 - Rover Requirement Document, issue 4.0
 - Reference Surface Mission (RSM) Scenario, issue
 - Experiment Interface Requirement Document (E-IRD), issue 8.0
 - **Rover Vehicle PDR and ALD PDR are now planned in Q2/Q3 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 elements



Rover design and development progress

2/3

- **Rover Vehicle equipment procurement has been resumed and is in progress; the following contracts 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:

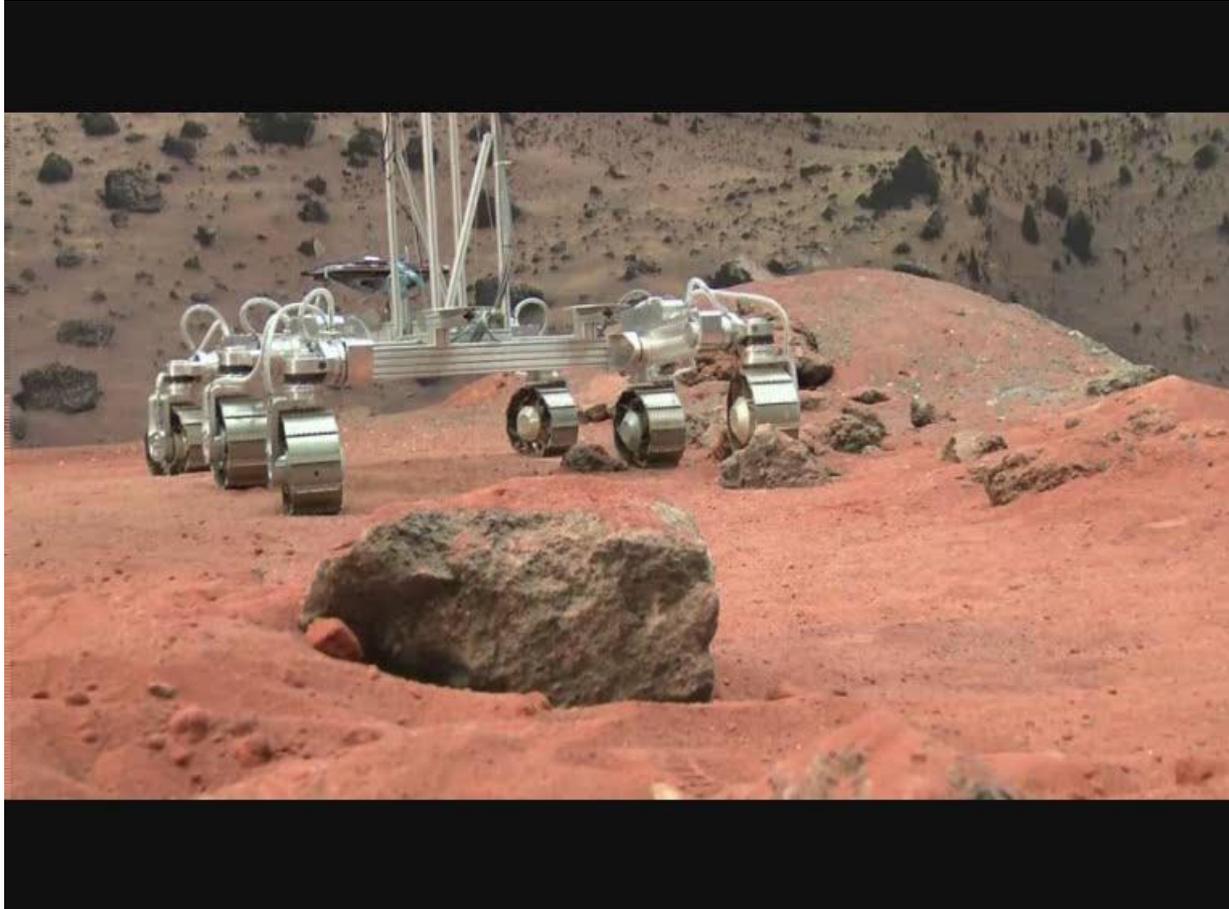
- IMU & sun sensor
- Deployable Mast Assembly
- Hold Down Release Mechanisms & Umbilical
- Battery
- SCOEs
- Solar Arrays Assemblies

Rover design and development progress

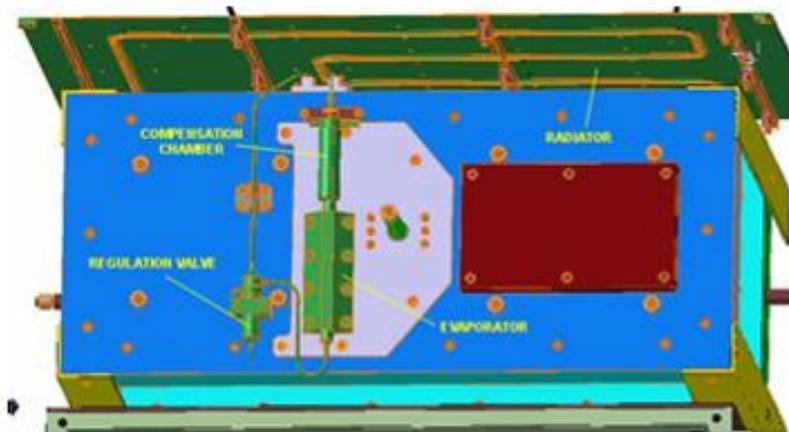
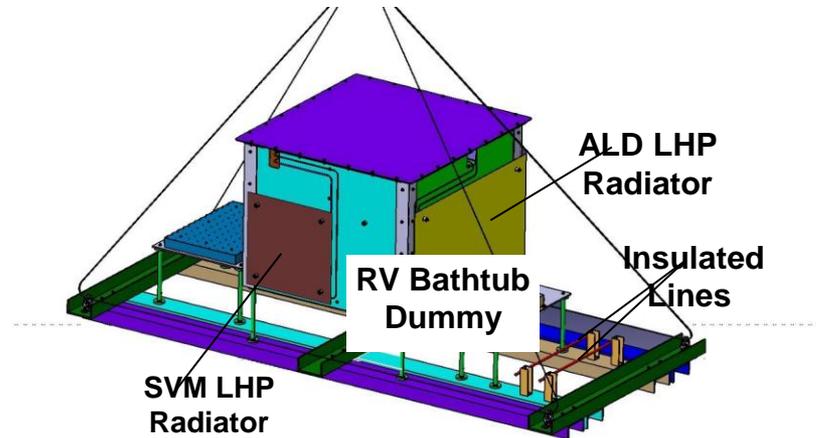
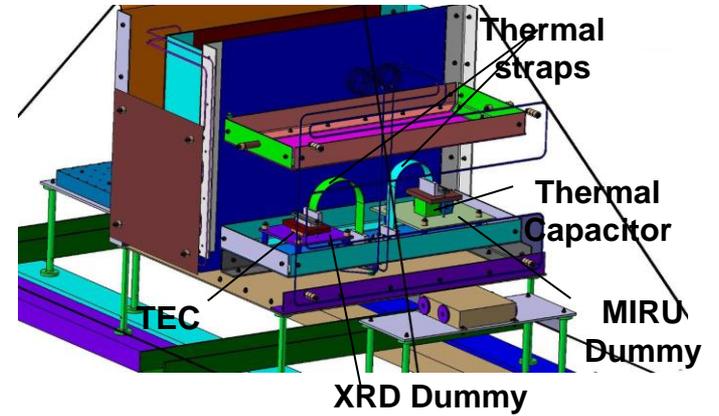
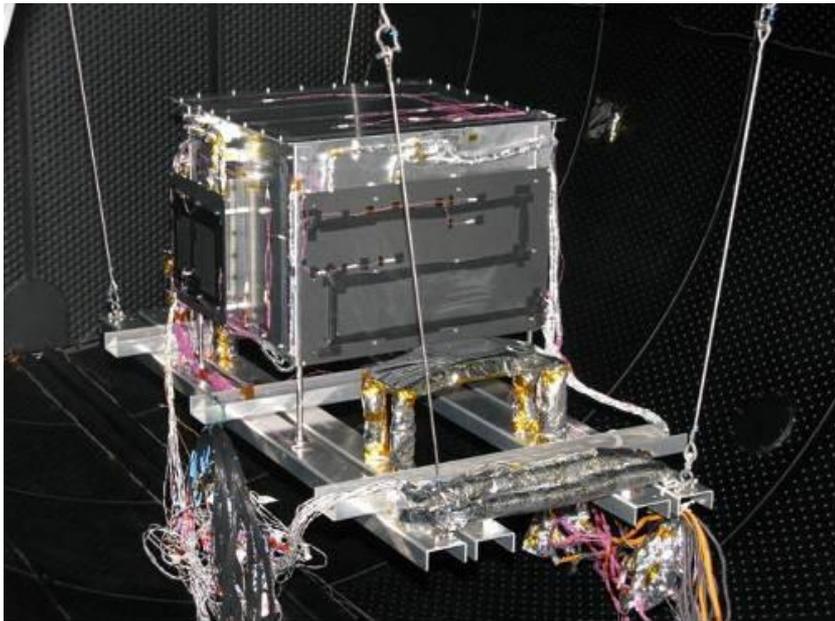
3/3

- **Rover technology developments continue:**
 - Mobility and GNC validation tests on going at ASU Mars Yard with latest Rover Breadboard (Mobility Development Model - MDM)
 - Loop Heat Pipes additional test planned in 2013
 - Drill pre-EQM test campaign in lab. conditions and with selected Mars-type materials completed in Dec 2012 (2 m depth)
 - Drill pre-EQM test in Mars like environment (2 m depth) completed in April 2013 , including preliminary test of Ma_Miss
 - 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 Lab. And Mars like conditions (Aarhus facility-DK) completed in April 2013
 - Test with ALD instr. BBs is foreseen in June 2013

Mobility System Locomotion Breadboard Test



LHP BB test

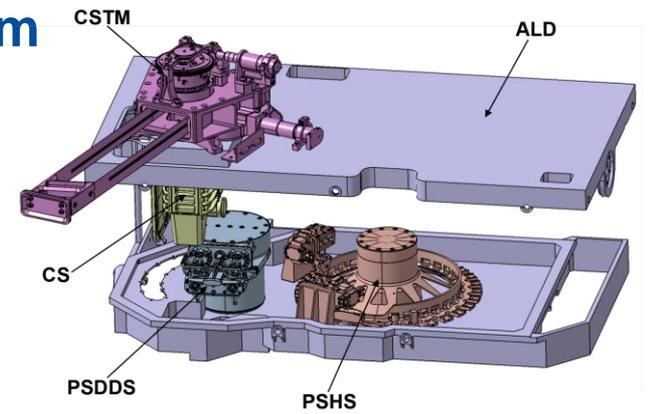
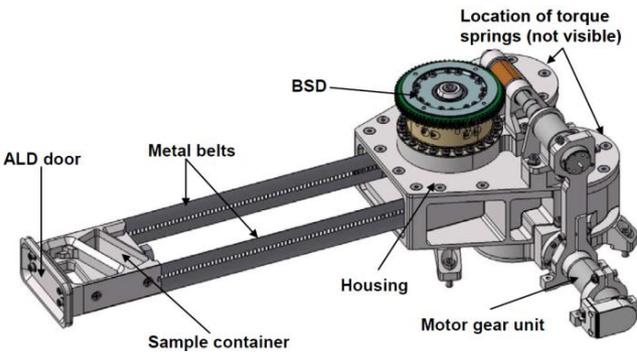


Drilling and sample discharge

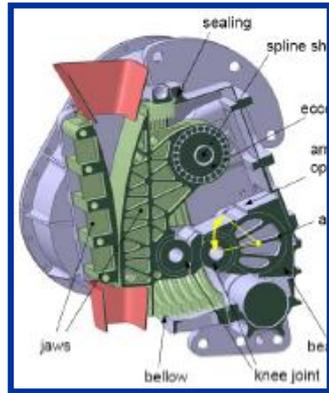
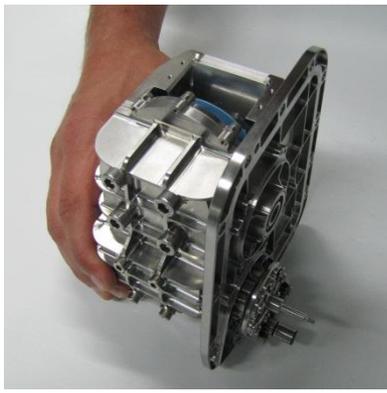
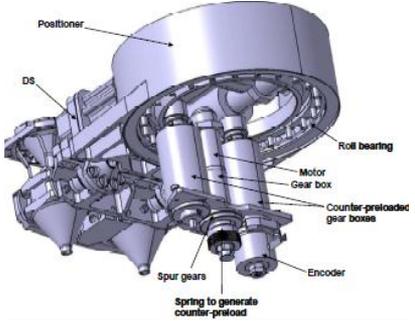


Note: Movies are accelerated

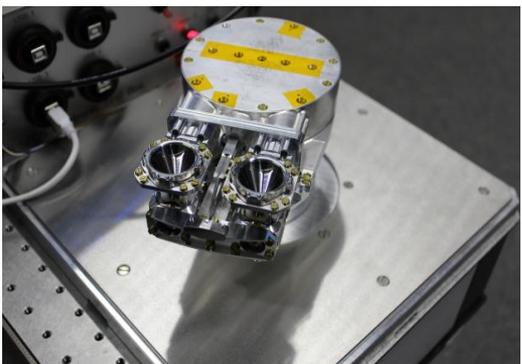
SPDS - Sample Preparation & Distribution System



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



Crushing Station (CS) EM

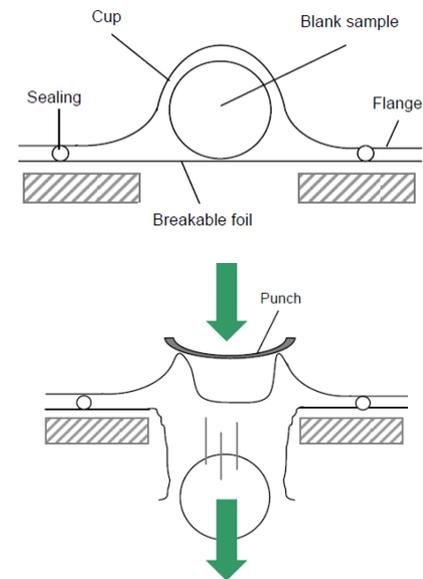
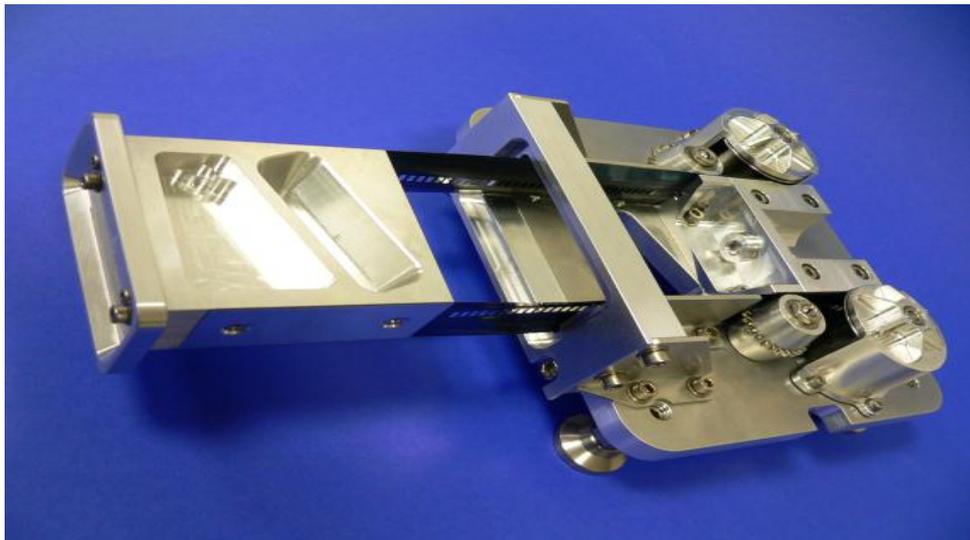
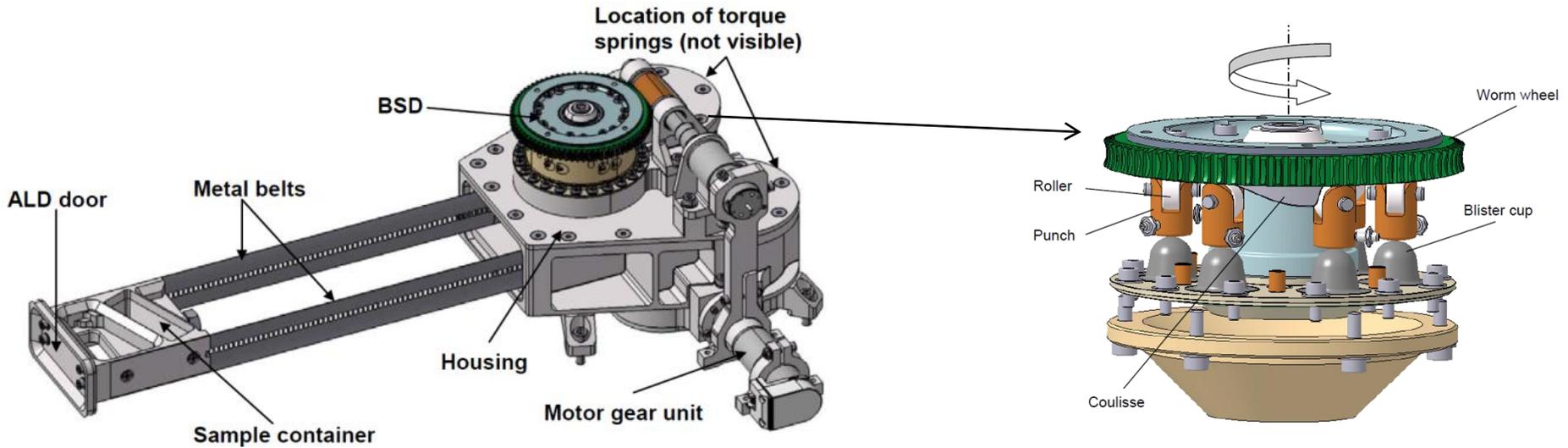


PSDDS: 2 Dosing stations + Positioner

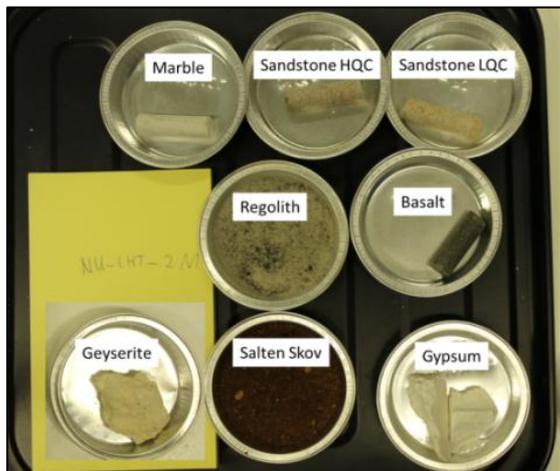
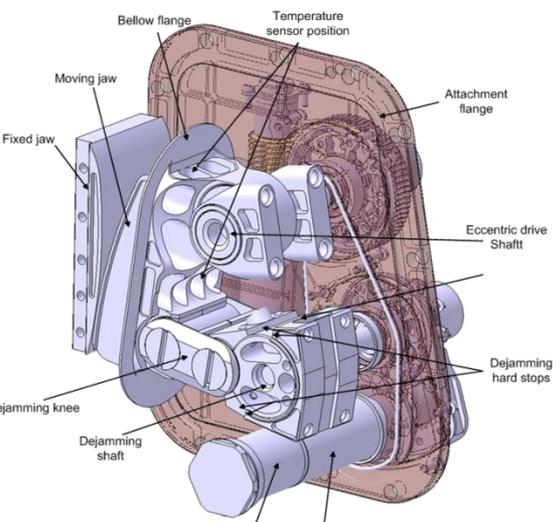
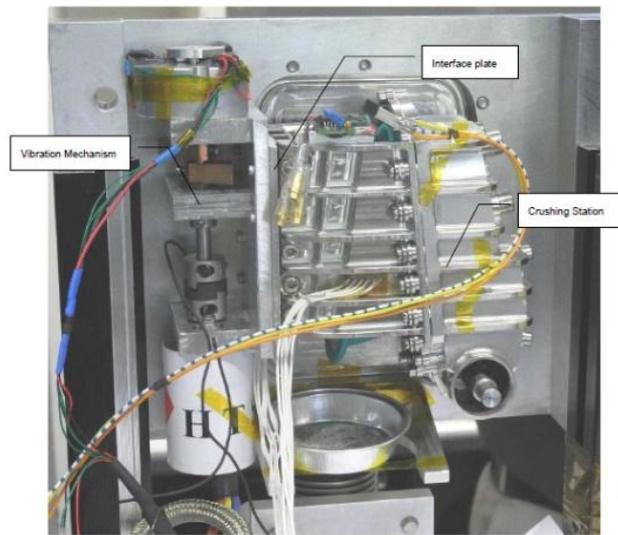
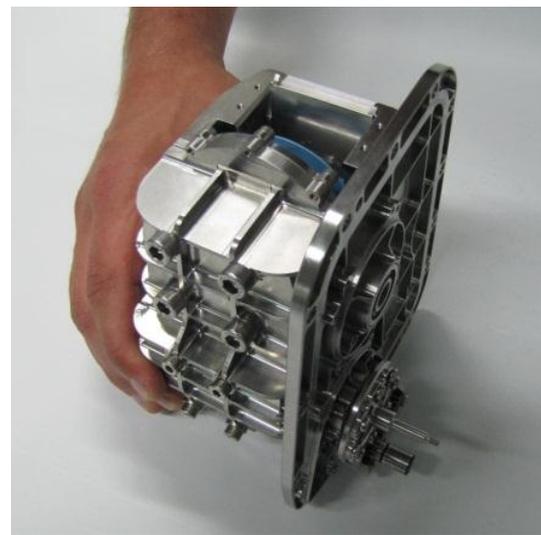
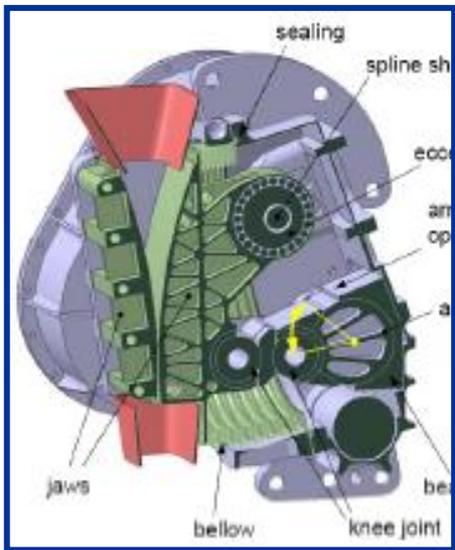


PSHS + RC + FD + GC ovens

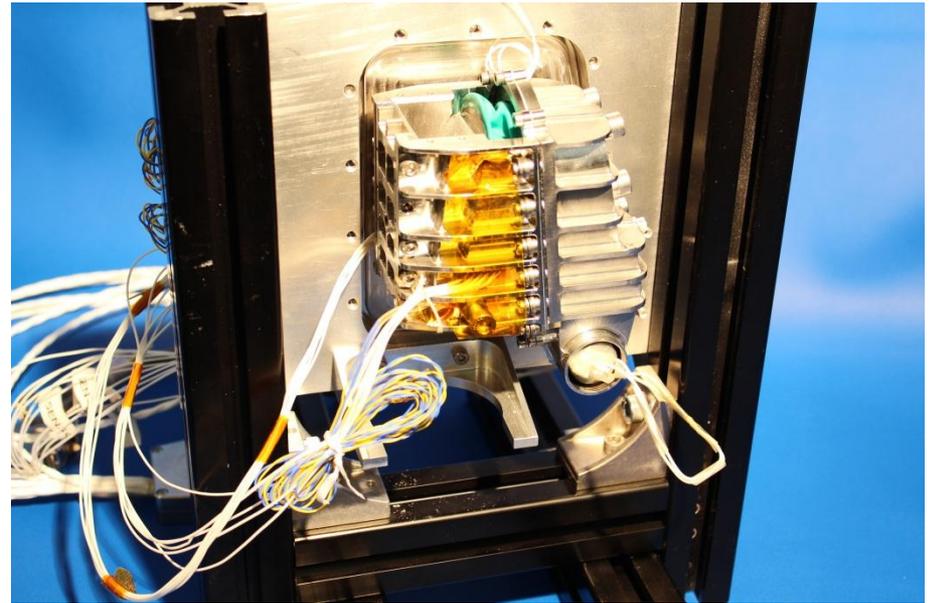
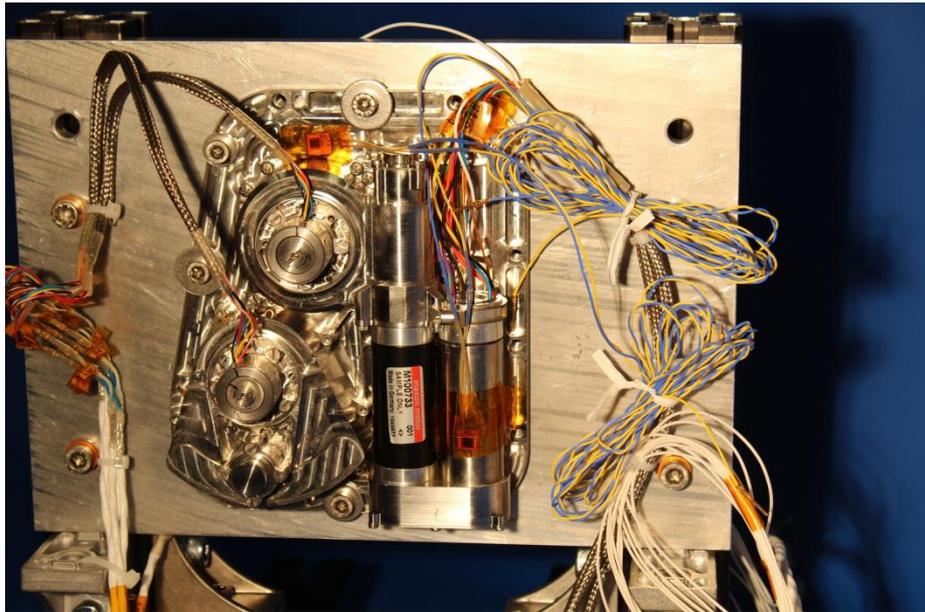
Core Sample Handling System (CSHS = CSTM + BSD)



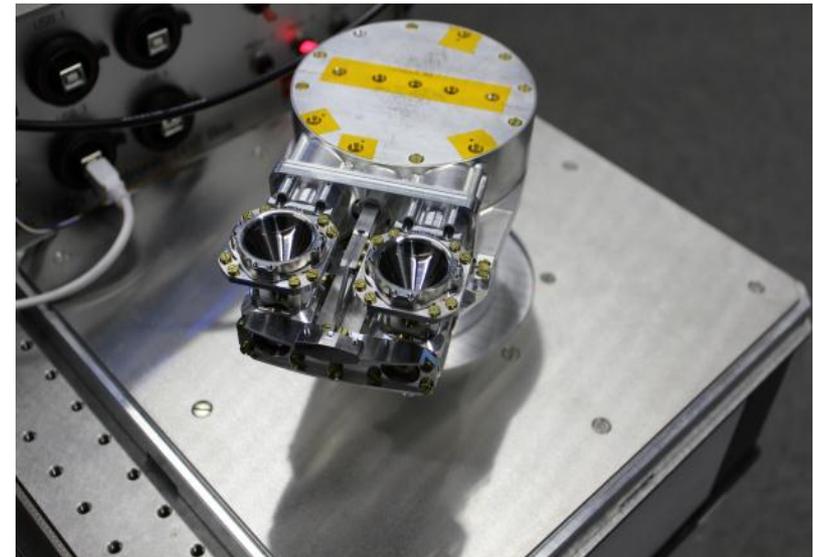
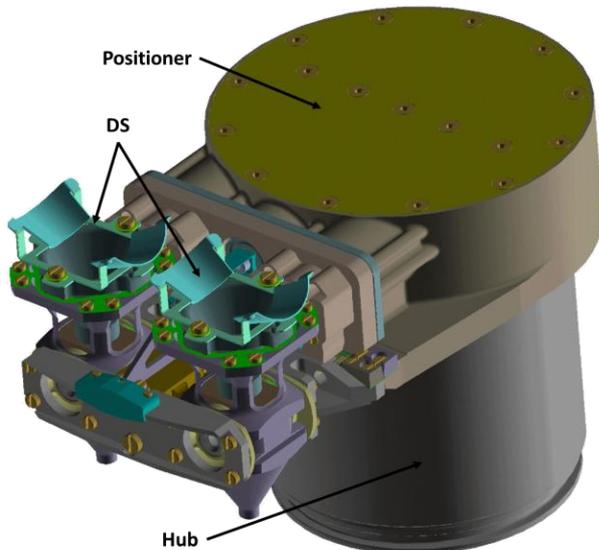
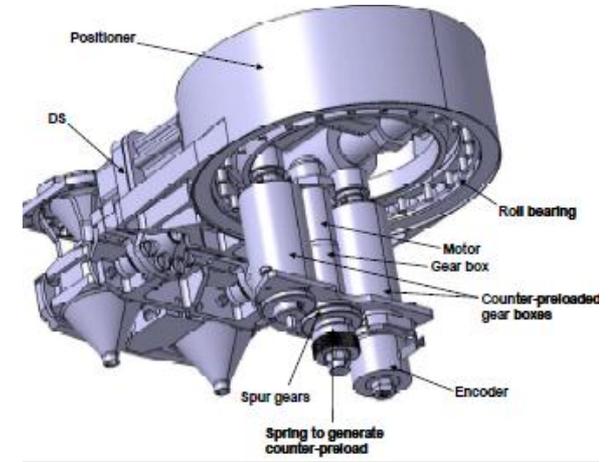
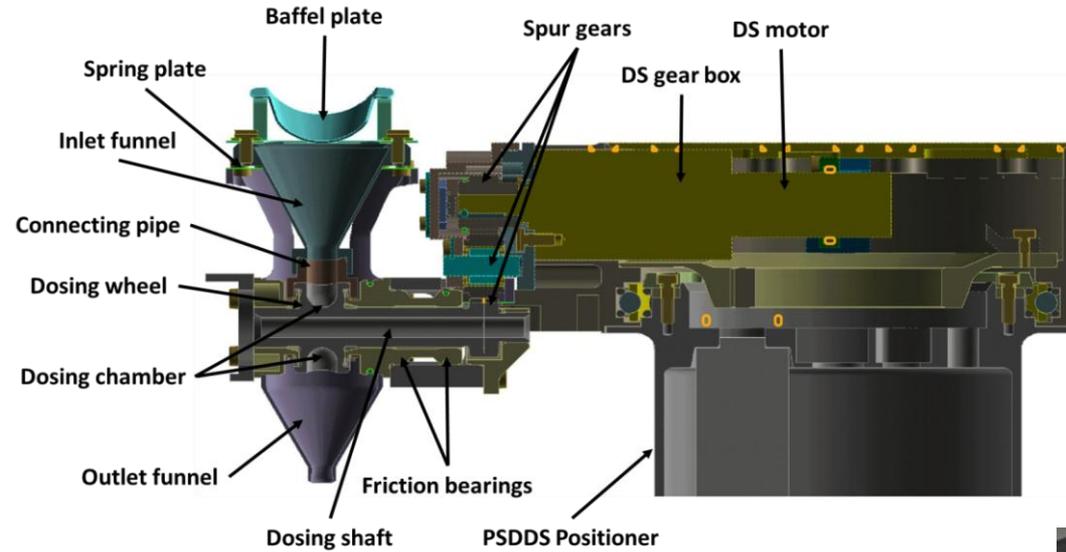
Crushing Station (CS)



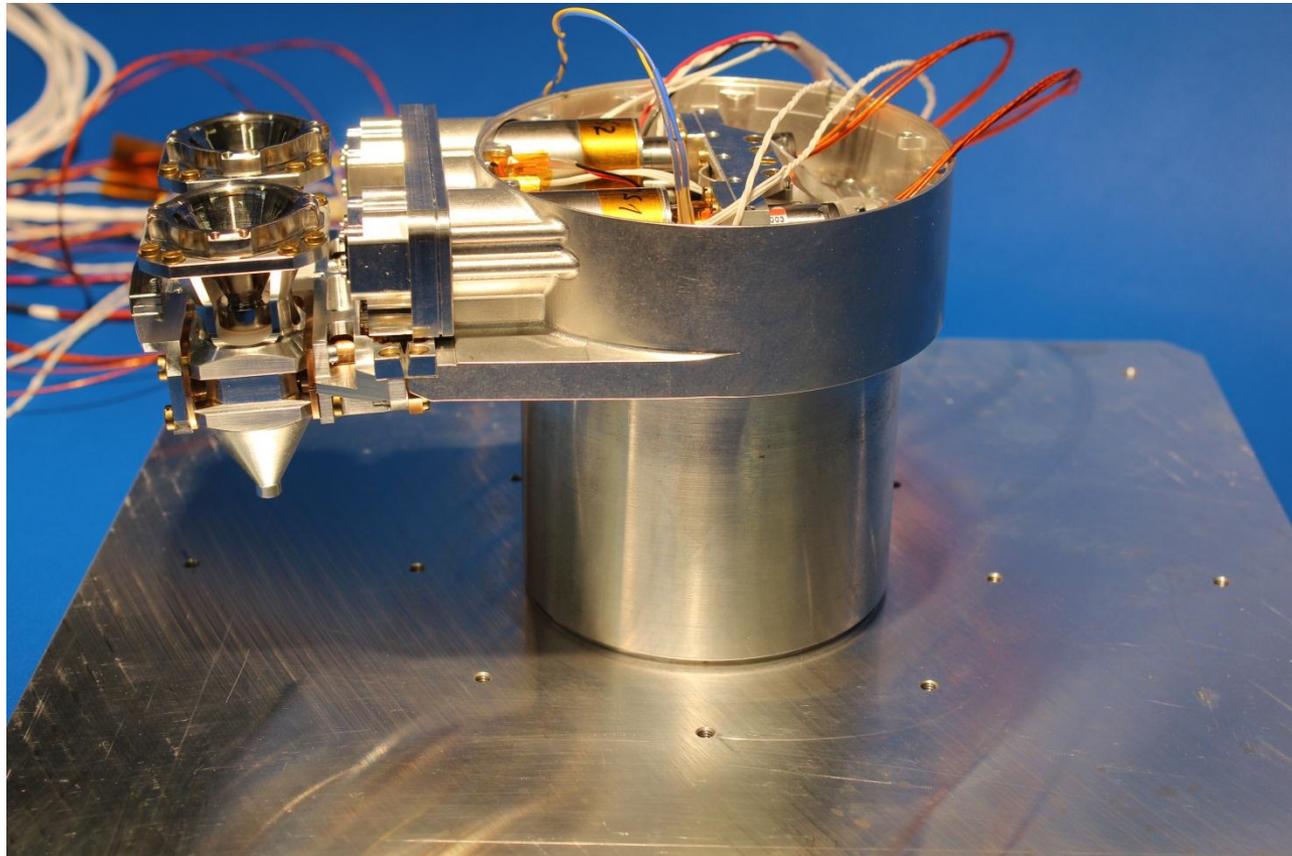
CS EM



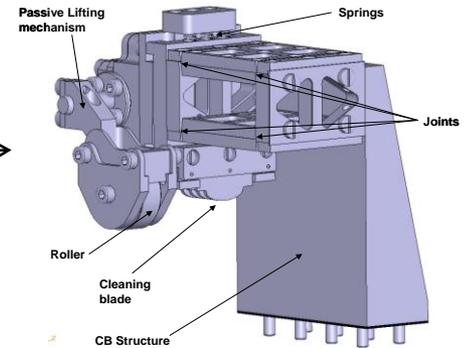
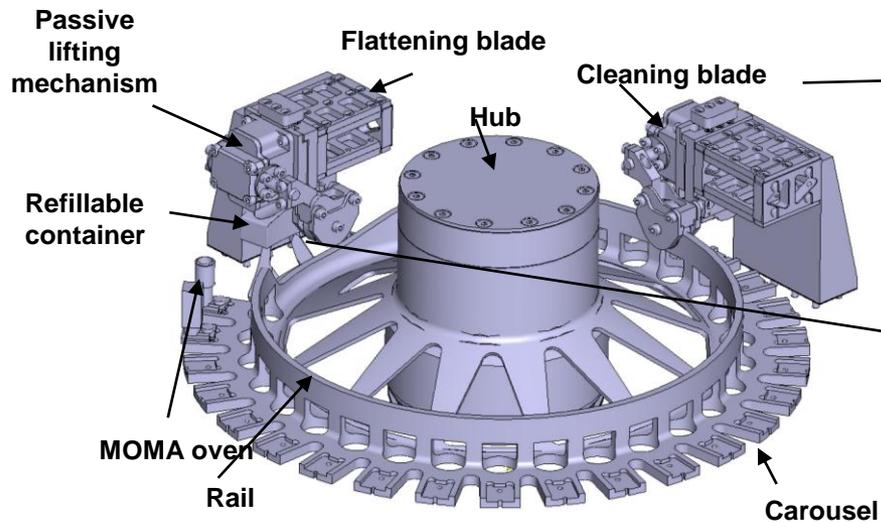
Powder Sample Dosing & Distribution System (PSDDS)



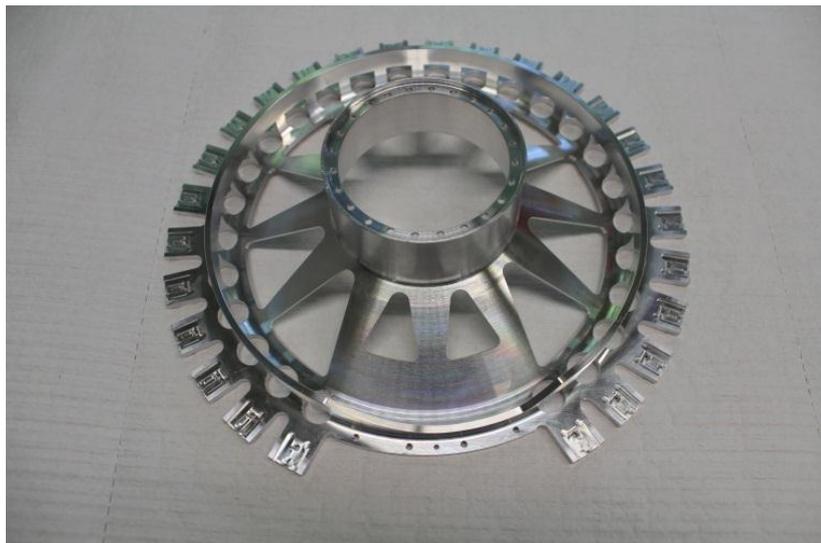
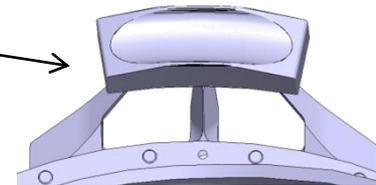
PSDDS EM



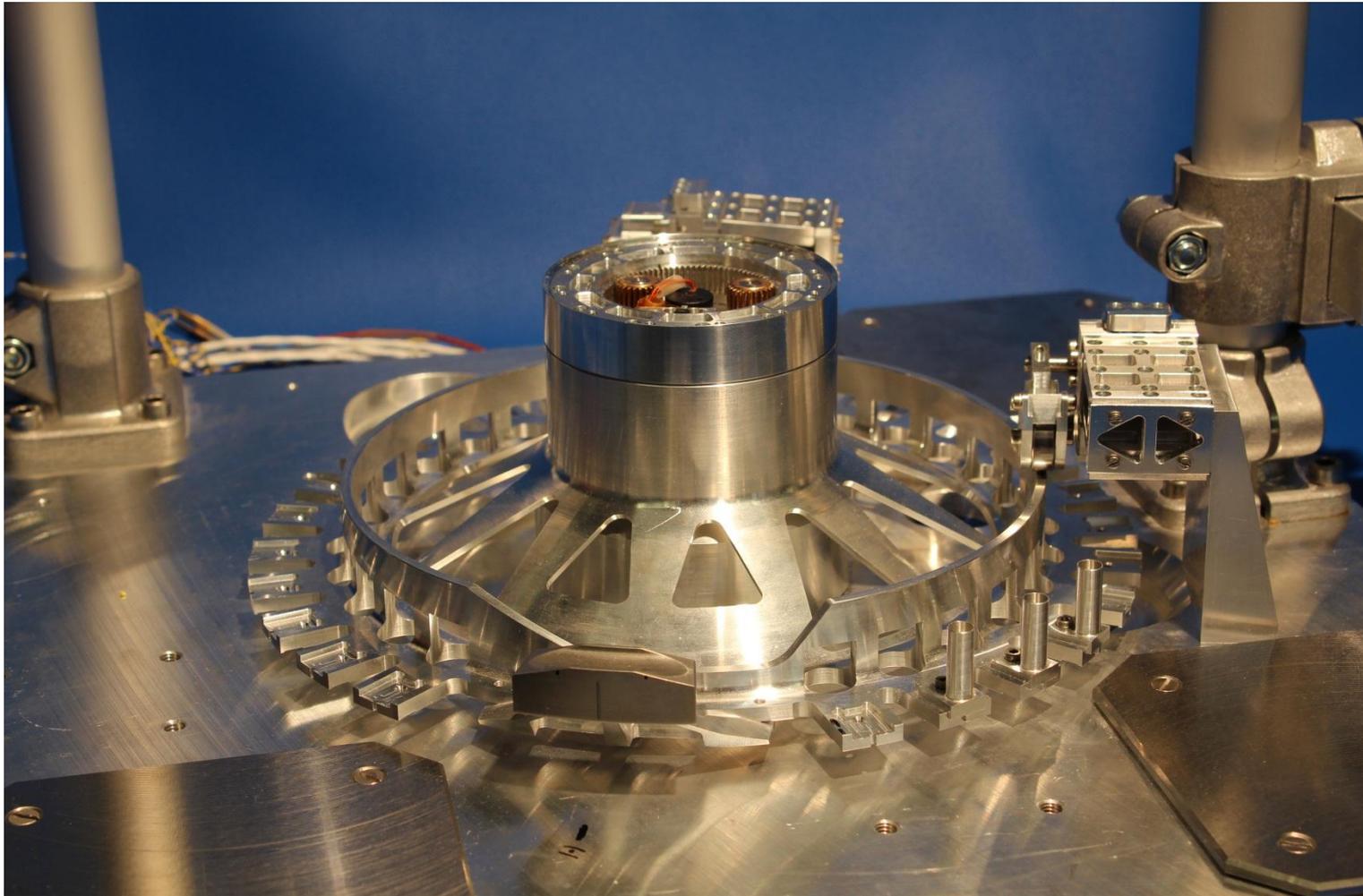
Powder Sample Handling System (PSHS)



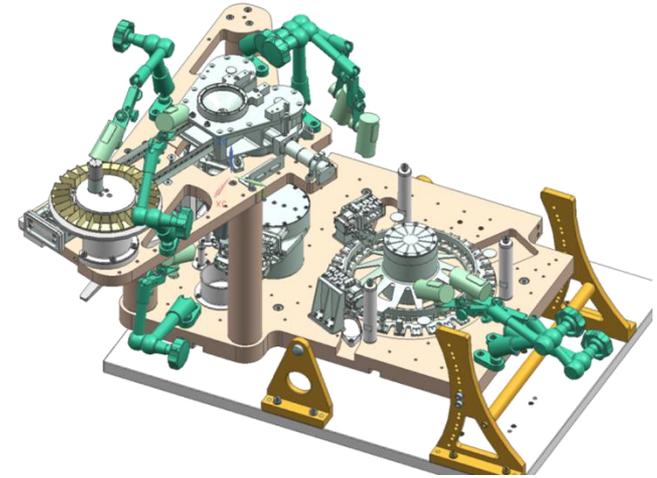
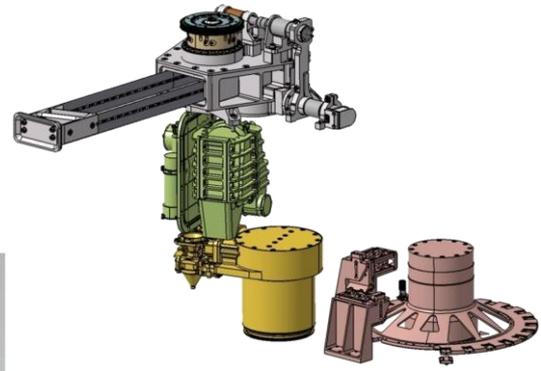
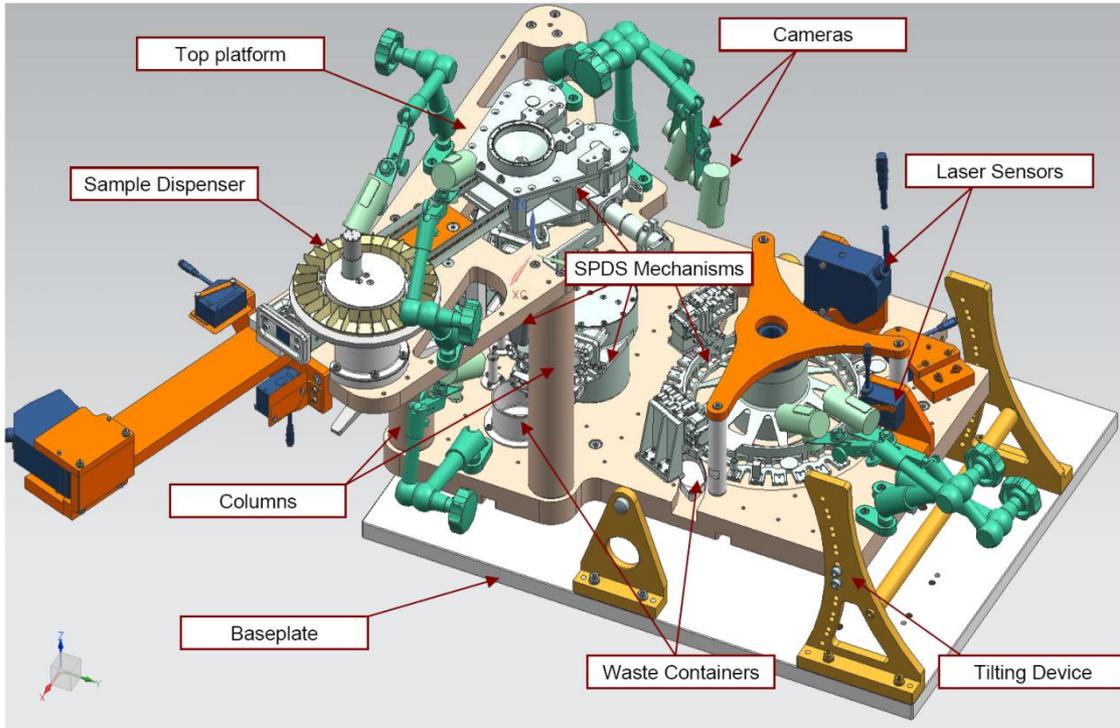
Refillable container



PSHS EM



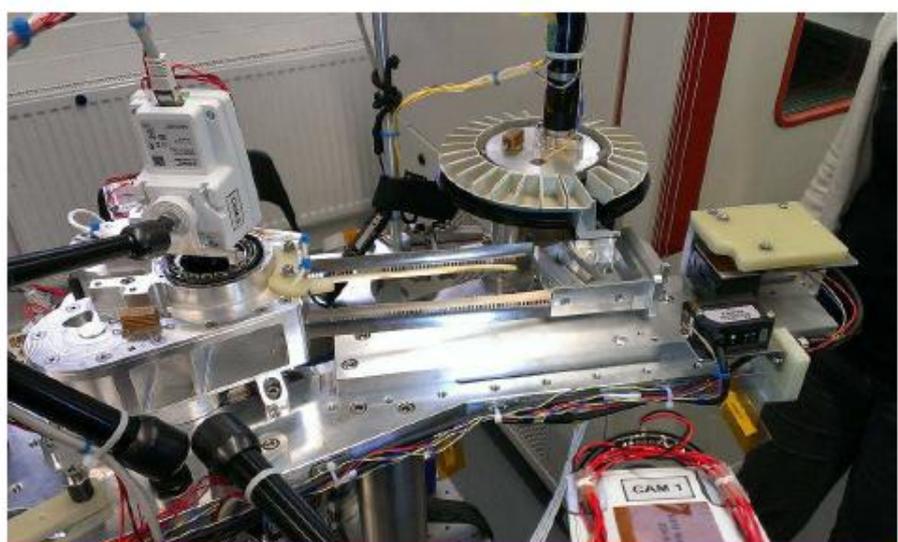
End-To-End (E2E) Test set –up



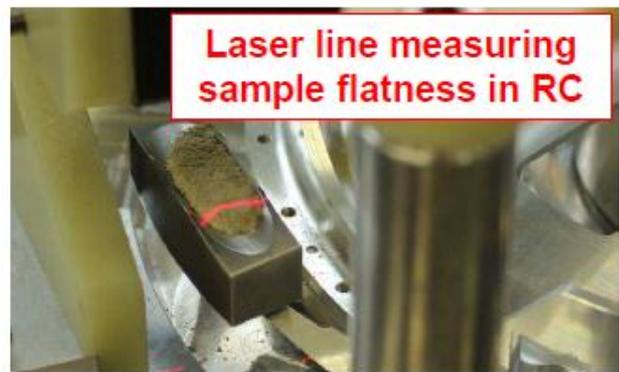
SPDS E2E Test set up

178

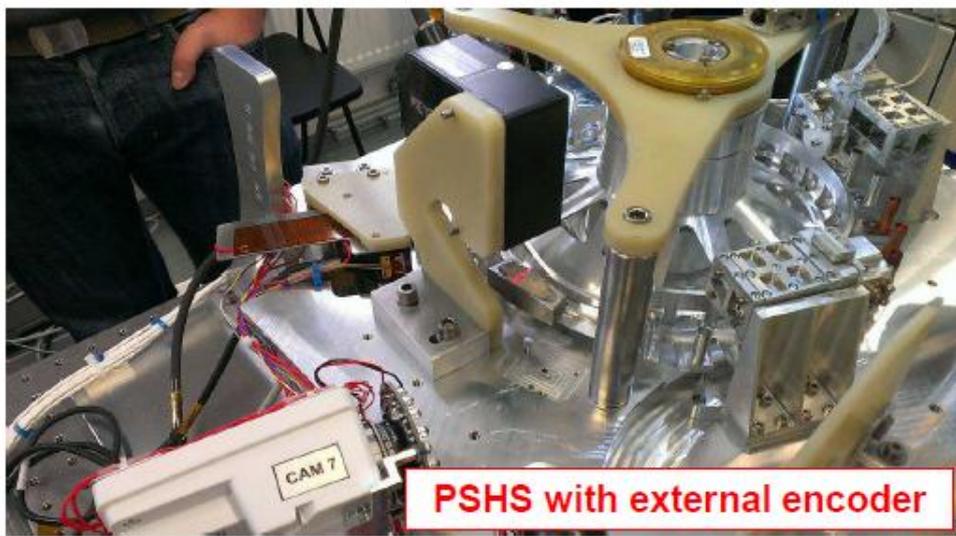
SPDS E2E Test Set-up



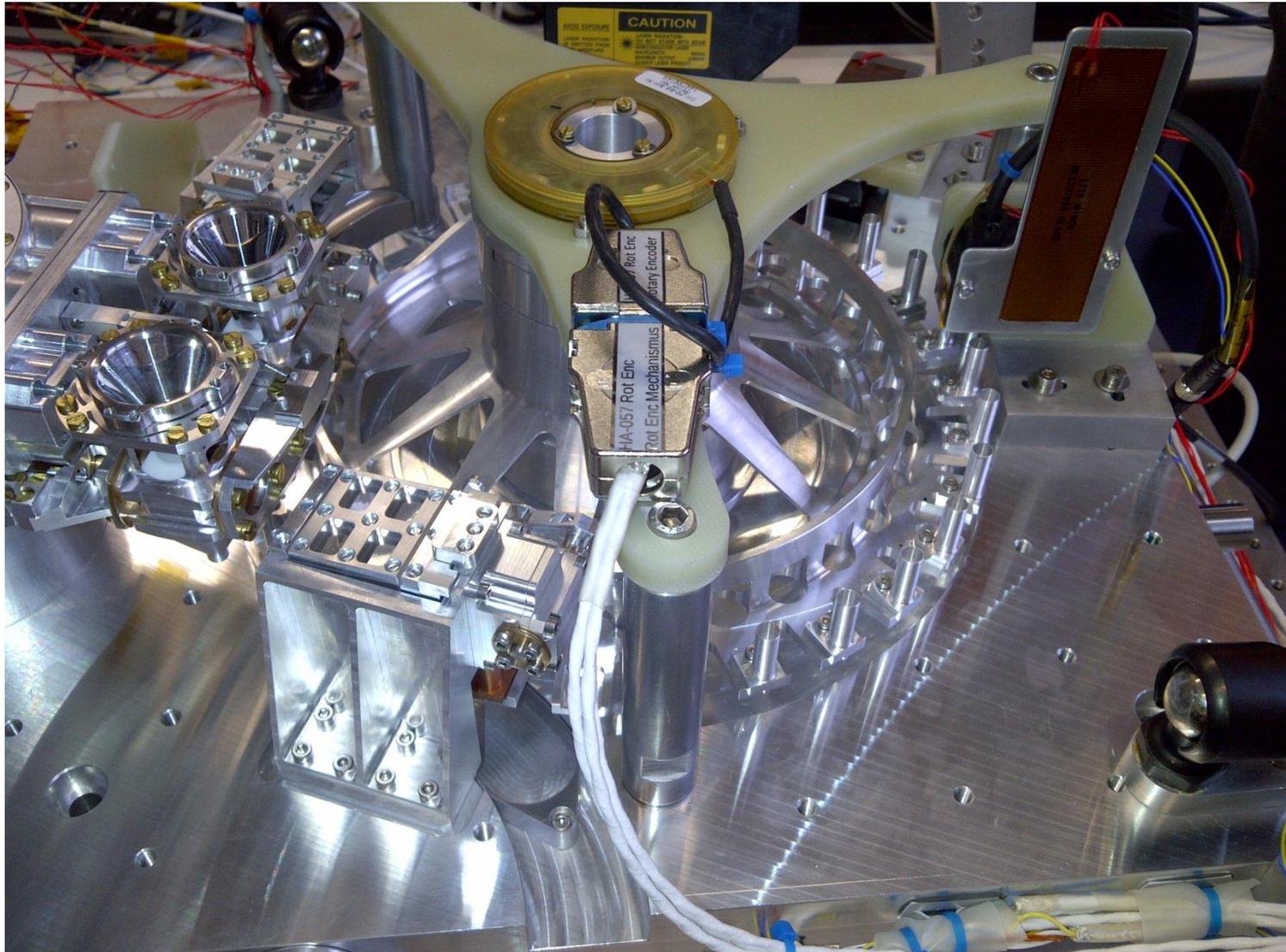
CSTM in open position and sample dispenser replacing the Drill for E2E test purpose



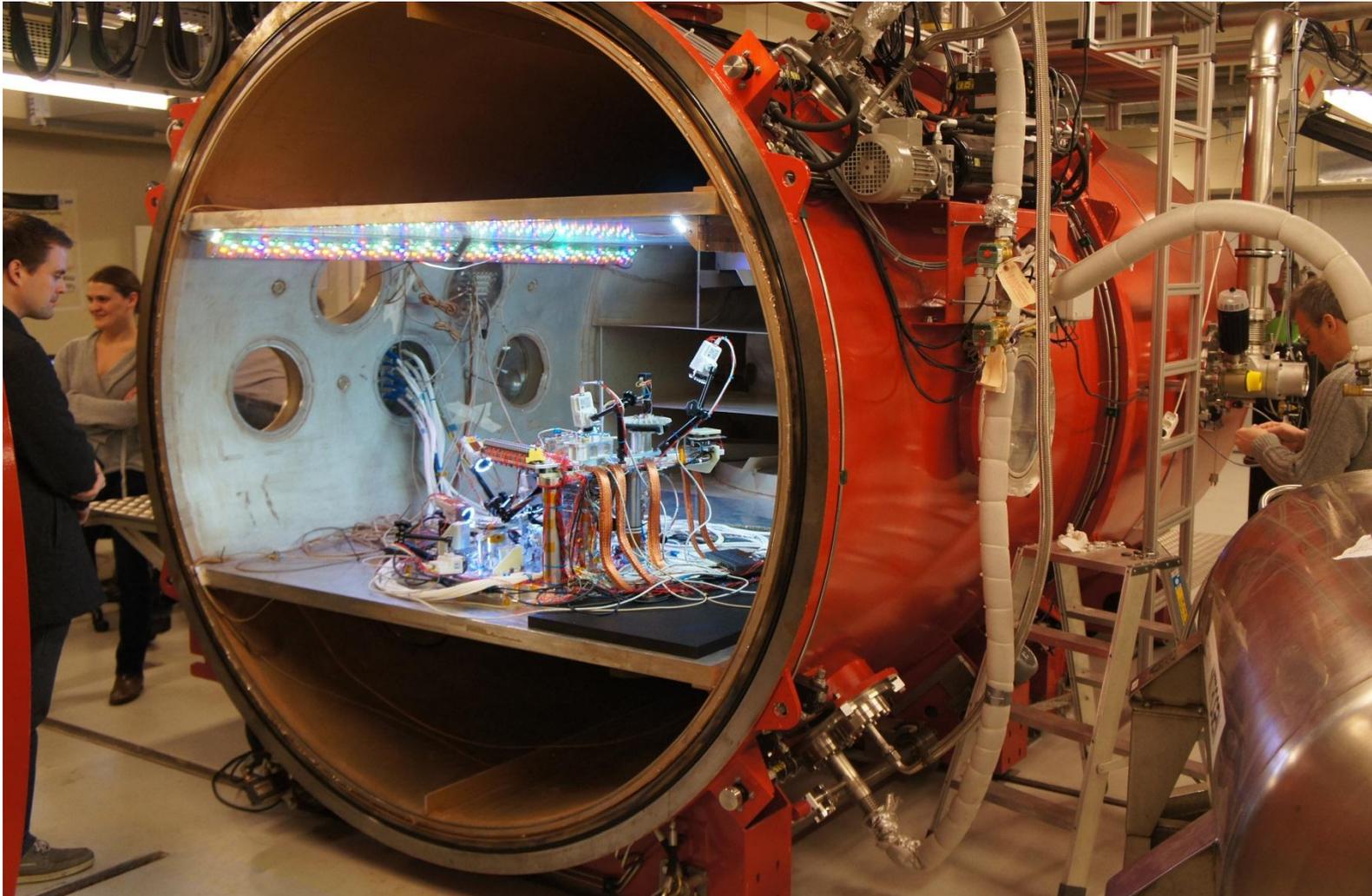
Laser line measuring sample flatness in RC



PSHS with external encoder



E2E SPDS Test in Mars Environment - Aarhus



Sample processing in the ALD

