Status of ESA's Mars Activities

MEPAG meeting

Silver Spring, 2 March 2016

- **Rolf de Groot**, Head of Exploration Coordination Office, ESA Science Directorate
- **Hakan Svedhem**, ExoMars 2016 Project Scientist, ESA Science Directorate
- **Bernardo Patti**, Head of ISS Programme and Exploration Department, ESA Human Spaceflight and Robotic Exploration Directorate
- **Sanjay Vijendran**, Future Mars Projects, ESA Human Spaceflight and Robotic Exploration Directorate

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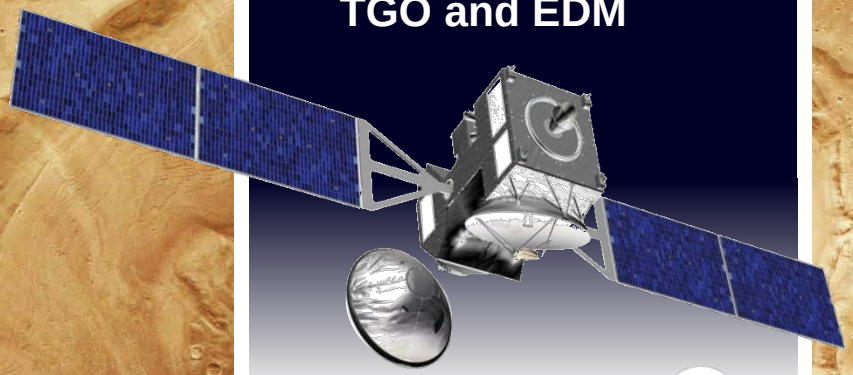
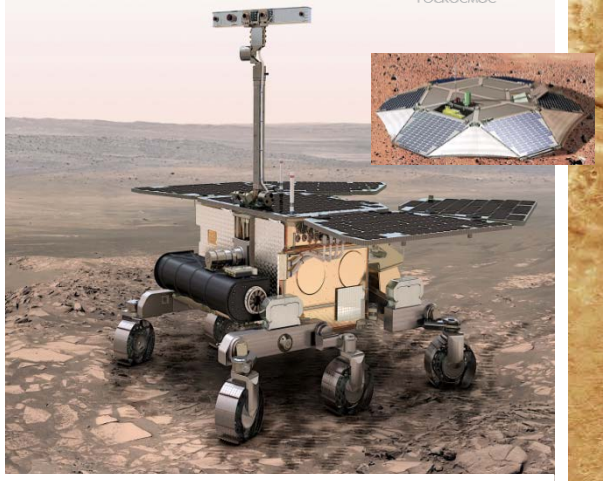
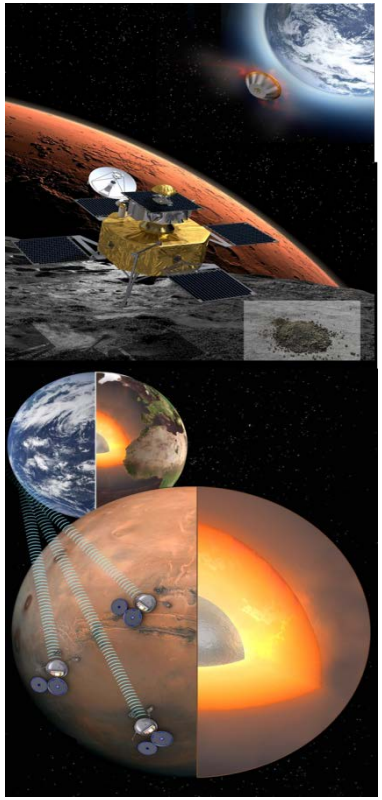
Mars Exploration at ESA



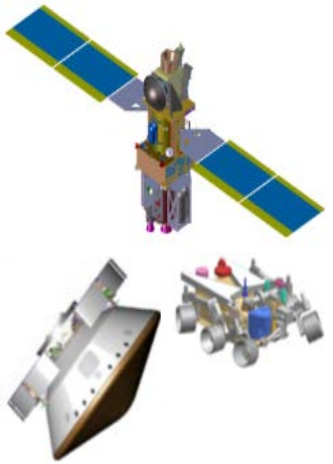
ExoMars



Rover + Platform



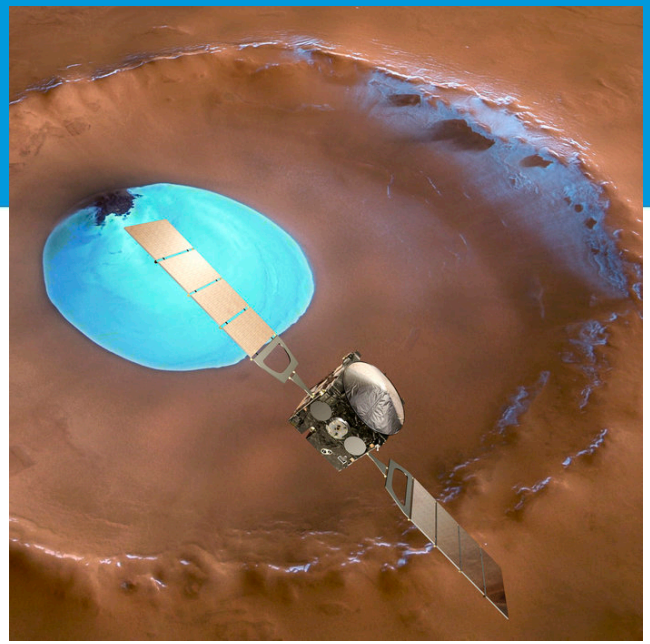
Mission studies



MSR elements

2003 2030+

Mars Express



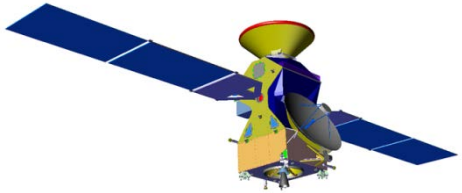
- Status:
  - Launched in 2003
  - Spacecraft and payload status: very good
  - Fuel and batteries estimates OK for ≥ 2021
  - Mission extension until end of 2018
- Recent events and activities
  - Coordinated measurements with the NASA MAVEN mission. Scientific objective: study of the plasma environment and atmospheric escape
  - 12 March 2015: Close Phobos flyby (61 km from center)
  - 14 June 2015: Mars Solar Conjunction
  - 14 January 2016 – Close Phobos flyby (52 km)
- October 2016: Mars Express relays data from the ExoMars entry and descent module

ExoMars Programme in cooperation with Roscosmos: ESA's flagship mission in Robotic Exploration

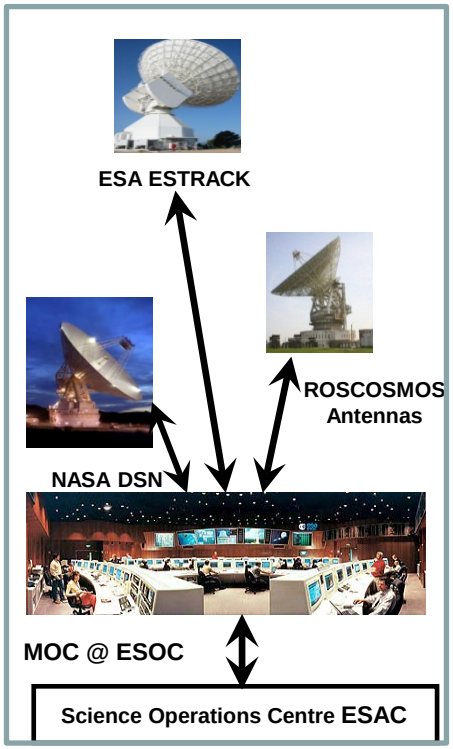
2016 Mission

Proton M/Breeze M

Trace Gas Orbiter (TGO)



EDL Demonstrator Module (EDM - Schiaparelli)

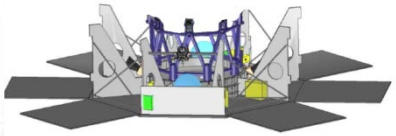


And

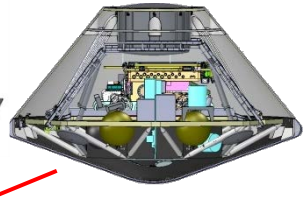
2018 Mission

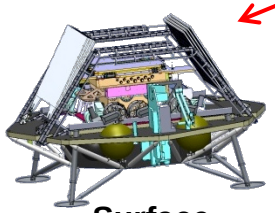
Proton M/Breeze M

Carrier Module (CM)

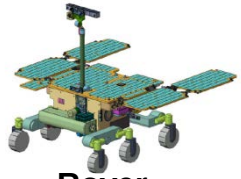


Descent Module (DM)





Surface Platform



Rover

LPOCC

ROCC

2016 Mission

Dedicated presentation by Hakan Svedhem

2018 Mission Objectives

EXOMARS

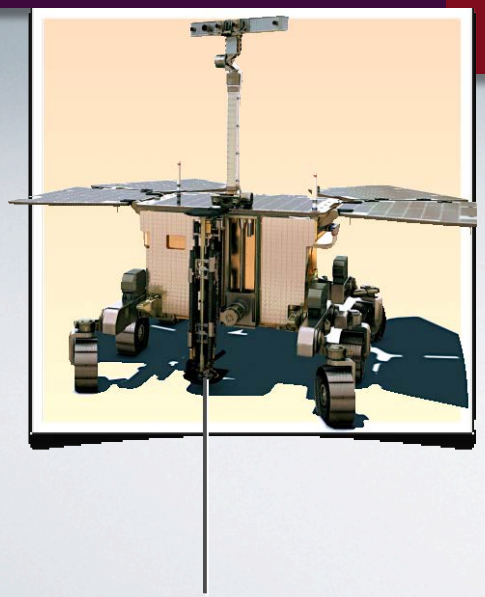
TECHNOLOGY OBJECTIVES

- 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.

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.

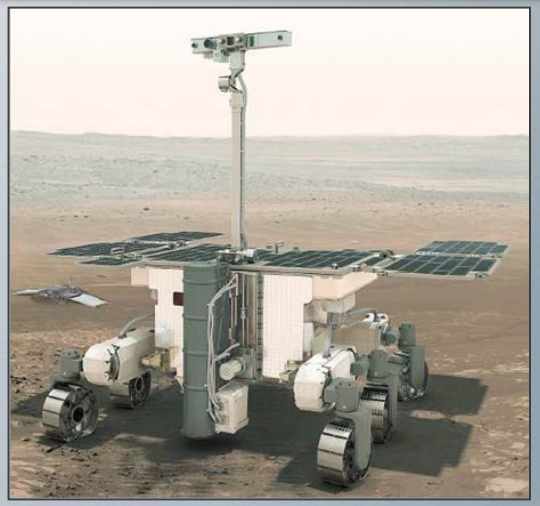


- To characterise the surface environment.

ExoMars 2018 status

ExoMars programmatic status

- ESA – Roscosmos ExoMars agreement signed (2013)
- ESA – NASA MoU on ExoMars 2016 signed (29 April 2014)
- Additional funding received at the Council at Ministerial Level in Luxembourg (2 December 2014)
- Final funding request planned for next Council at Ministerial Level (December 2016)



2018 ExoMars Mission (CM, DM, Rover)

- 2018 System Preliminary Design Review (S-PDR) closed-out in May 2015
- The 2018 mission is in Phase C/D
- Negotiations with Industry on final Proposal for C/D/E1 to be finalised in April 2016
- 2018 schedule very critical (European and Russian industry)
- 2020 back-up schedule is being established in paralell
- Rover instruments are progressing, but some critical for 2018 schedule
- European contributions to Russian Surface Platform selected in November 2015
- Landing Site Selection process on-going (*H. Svedhem presentation*)

ExoMars 2016 brief overview and present status

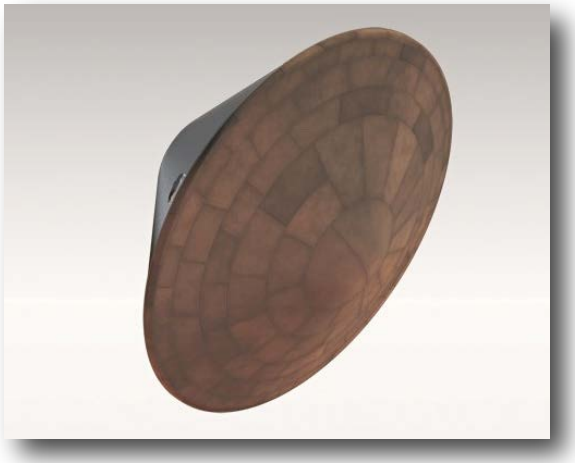
Håkan Svedhem, Rolf de Groot, Jorge Vago
ESA/ESTEC

MEPAG 2 March 2016

The ExoMars 2016 mission

❑ Main components

- ➢ The Trace Gas Orbiter, TGO, - an orbiter focussing on detection and characterisation of trace gasses and their isotopes, searching for sinks and sources, and seasonal and spatial variations
- ➢ Schiaparelli – an Entry, Decent and Lander Demonstrator Module (EDM), including a short lived surface meteorology package
- ➢ Both spacecraft will be launched together on a Proton-M/Breeze-M vehicle from Baikonur



2016 Mission Objectives

EXOMARS

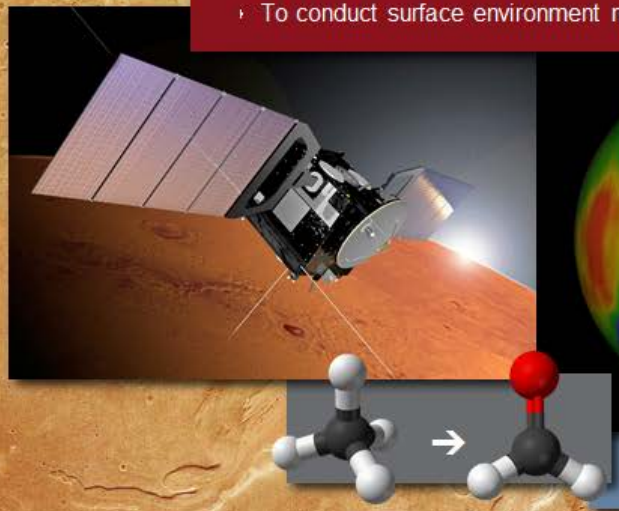
2016

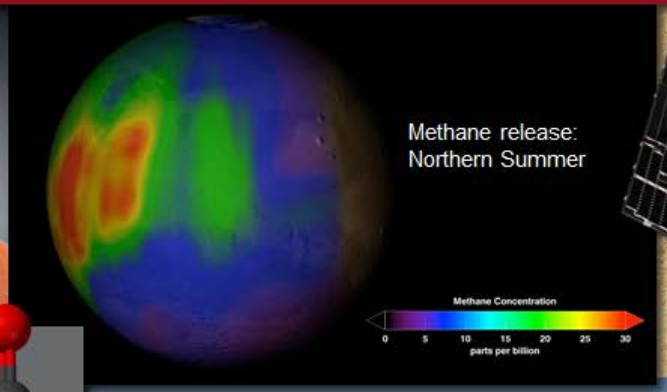
TECHNOLOGY OBJECTIVE

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

SCIENTIFIC OBJECTIVES

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





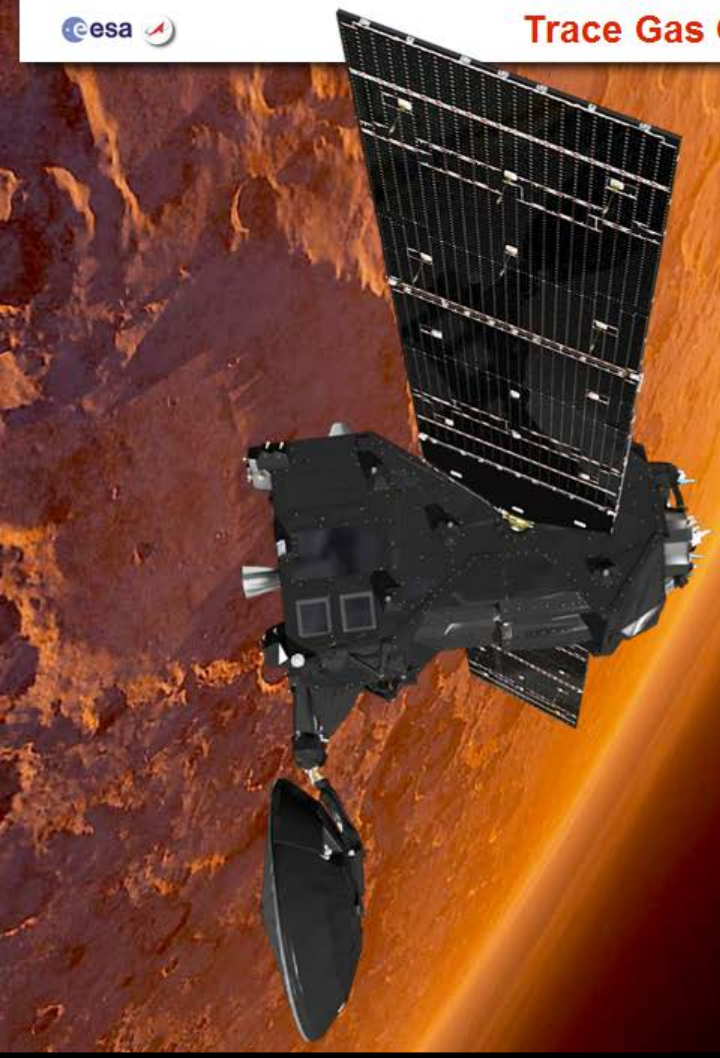
- Data relay services for landed missions until 2022.

Credit: Mamers Valles, MEX/HRSC

Mission phases/main events

- 14 March 2016 Launch (L-window 14-25/3)
- 16 October 2016 EDM separation
- 19 October EDM landing
- 19 October TGO MOI, capture orbit P=4 sols
- mid December apocentre lowering to P=1 sol
- Jan 2017- Dec 2017 Aerobraking
- Dec 2017 start of science mission
- Jan 2019 start of Data relay for ExoMars 2018 Rover and surface platform mission
- Dec 2019 End of science mission (present funding)
- Dec 2022 End of rover/surface relay mission (present funding)

Trace Gas Orbiter



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
Mid-IR (2.3 – 4.5 µm) λ/Δλ ~50,000	SO		

FREND
Collimated neutron detector

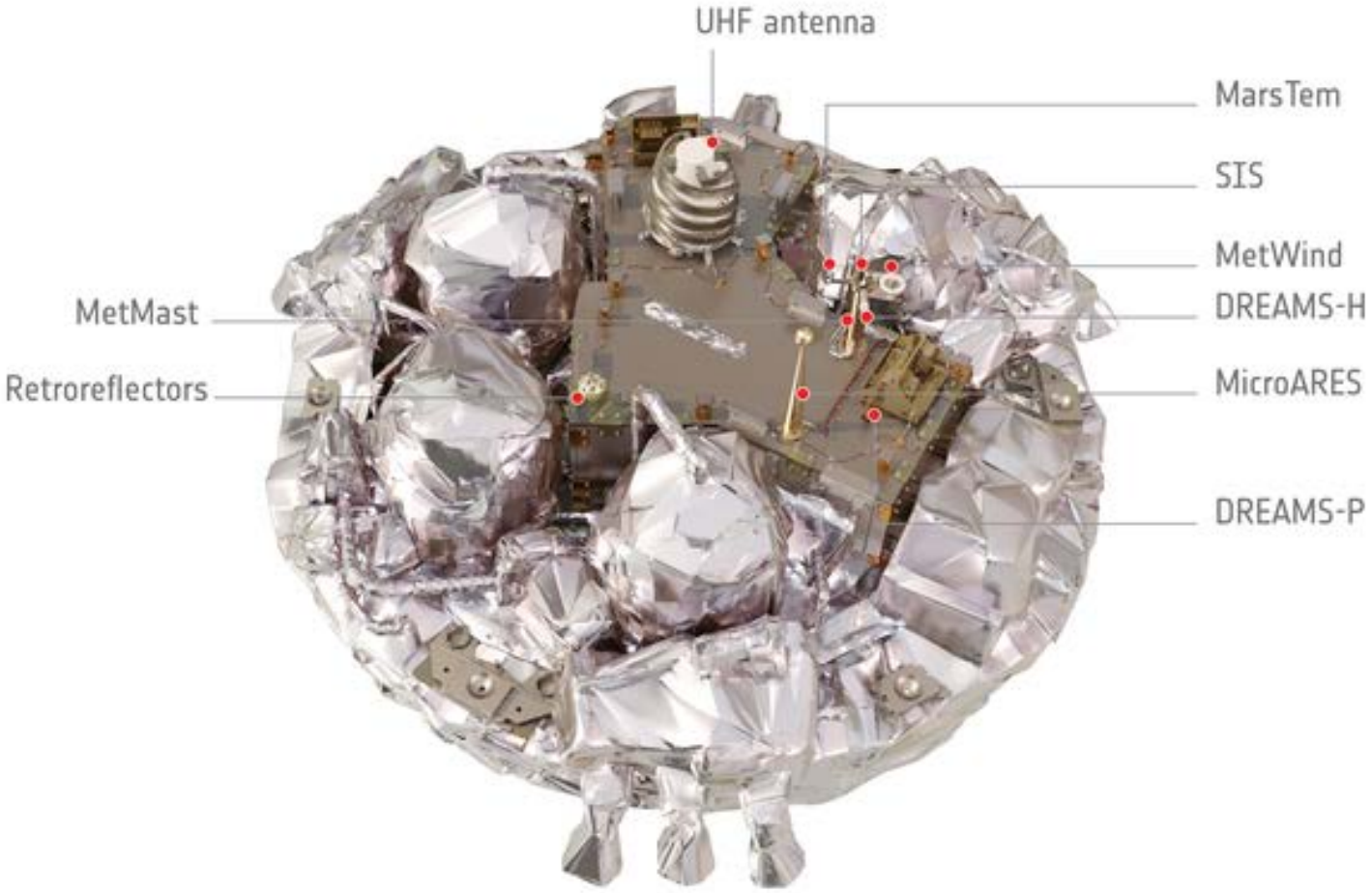
Mapping of subsurface water and hydrated minerals

Credit: ESA/Medialab, Kees Veenenbos

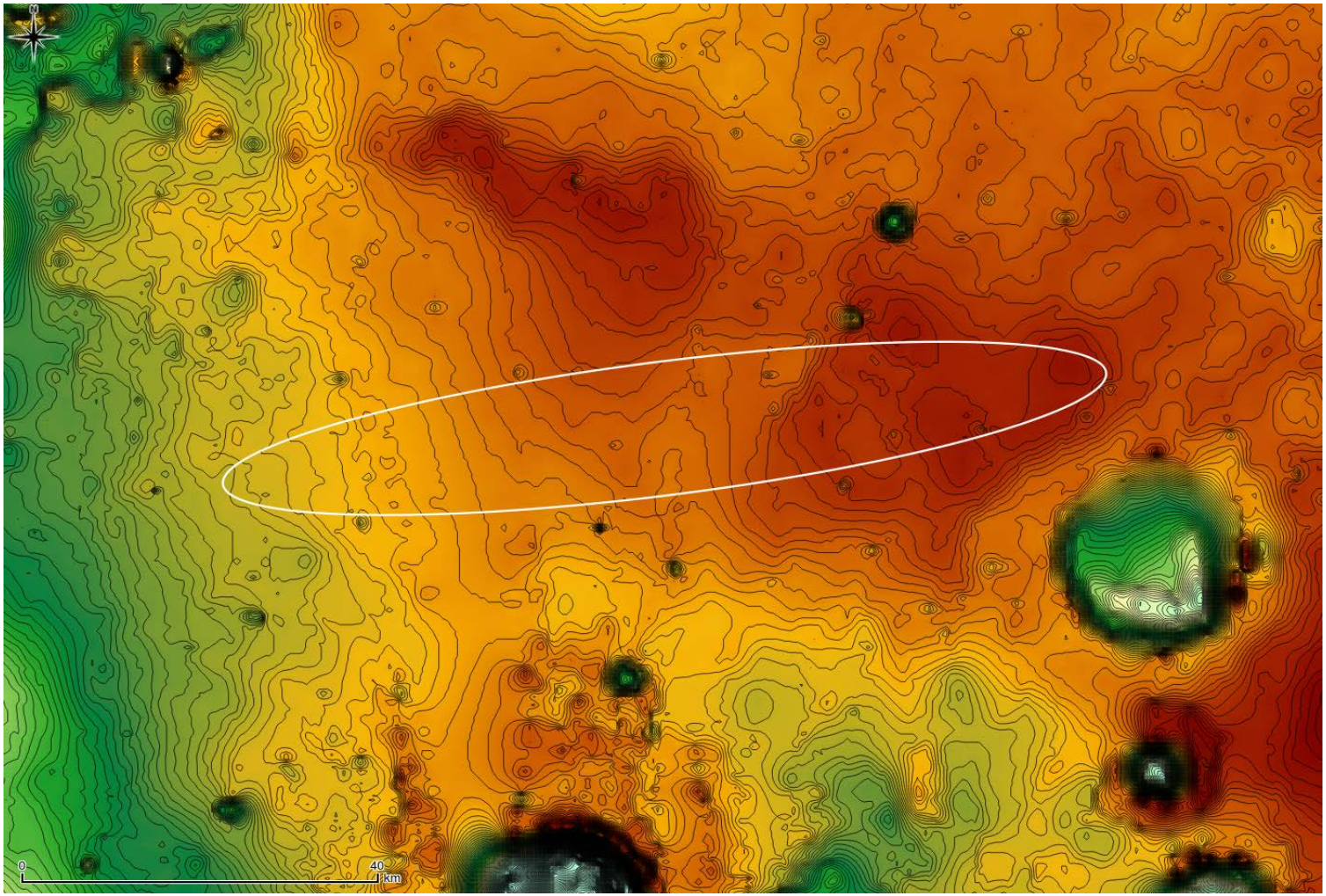
TGO science orbit

- Near circular, frozen orbit
- Inclination 74 deg
- Argument of pericentre 270 deg (+/-3.5 deg)
- Pericentre altitude around 380 km
- Apocentre altitude around 430 km
- Ground track repetition rate:
  - 373 orbits in 30 sols
  - Ground track spacing at equator 28.6 km

Schiaparelli, w/o heat shield & back cover



Schiaparelli landing ellipse, 100km x 15km, in Meridiani Planum



Centre: 6.1 deg W, 2.05 deg S

10 Feb. Preparing for final mating of EDM onto TGO in Baikonur

12 Feb. Final mating of the EDM onto TGO in Baikonur, next separation 16 October, three days before arriving at Mars

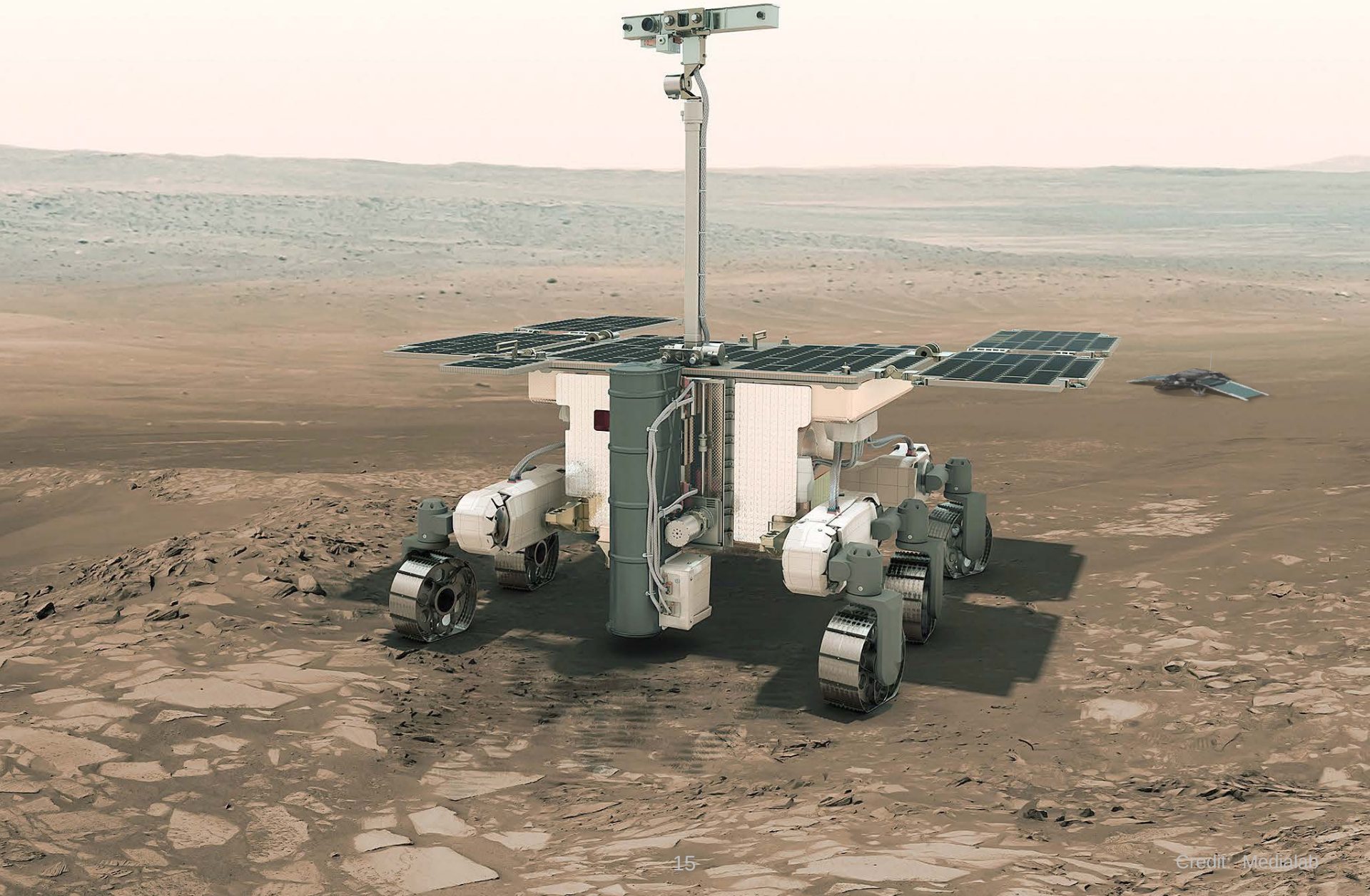
22 Feb. TGO during fuelling in Baikonur.

ExoMars 2016 status

- **Schiaparelli, EDM**
  - Fully tested and fuelled, ready for launch
- **TGO**
  - Fully tested and fuelled, ready for launch
- **Schiaparelli mounted on top of TGO in launch configuration**
- **Spacecraft operations and all ground systems ready**
- **Combined activities and launch preparations with Russian launch authorities started 29 February**
  - S/C mated with Launcher Upper Stage (Breeze-M)
  - P/L fairing closed
  - 5 March P/L-Upper Stage combination mating to Launcher
  - 9-10 March Upper Stage fuelling
  - 11 March Moving launcher to launch pad
- **All systems green for launch on 14 March 09:31 UT.**
  - Launch window remains open until 25 March

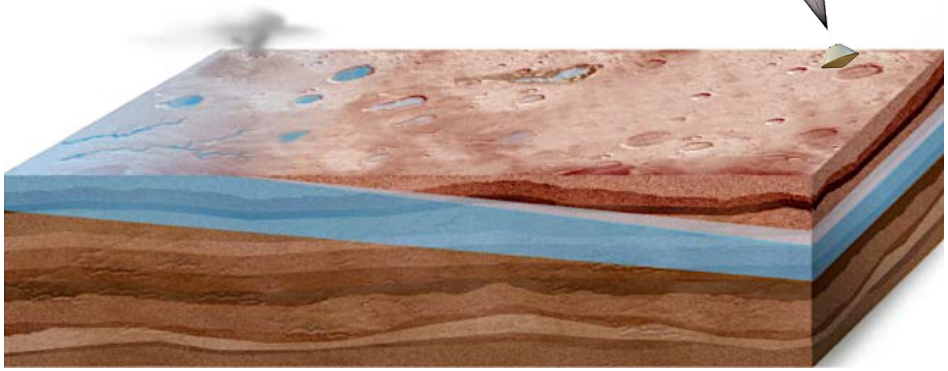
PROTON

2018 Landing site selection



Credit : Medialab

What do we need?



Search-for-life objectives…

- **We are interested in:**

1. **Age:** Period in martian history when water-lain sediments could have been deposited.
2. **Deposits**: Fined-grained sediments deposited under low-energy water conditions, possibly influenced by hydrothermal processes, that we can associate with life favourable conditions (e.g. ponded water).
3. **Preservation:** Not just old sites, but old sites recently exhumed (protection against radiation).
4. **Targets:** Distribution of prime science targets in the landing ellipse. How likely is it that we will land upon or be able to reach them with a short traverse?

Credit: Dust devil tracks, MRO/HiRISE

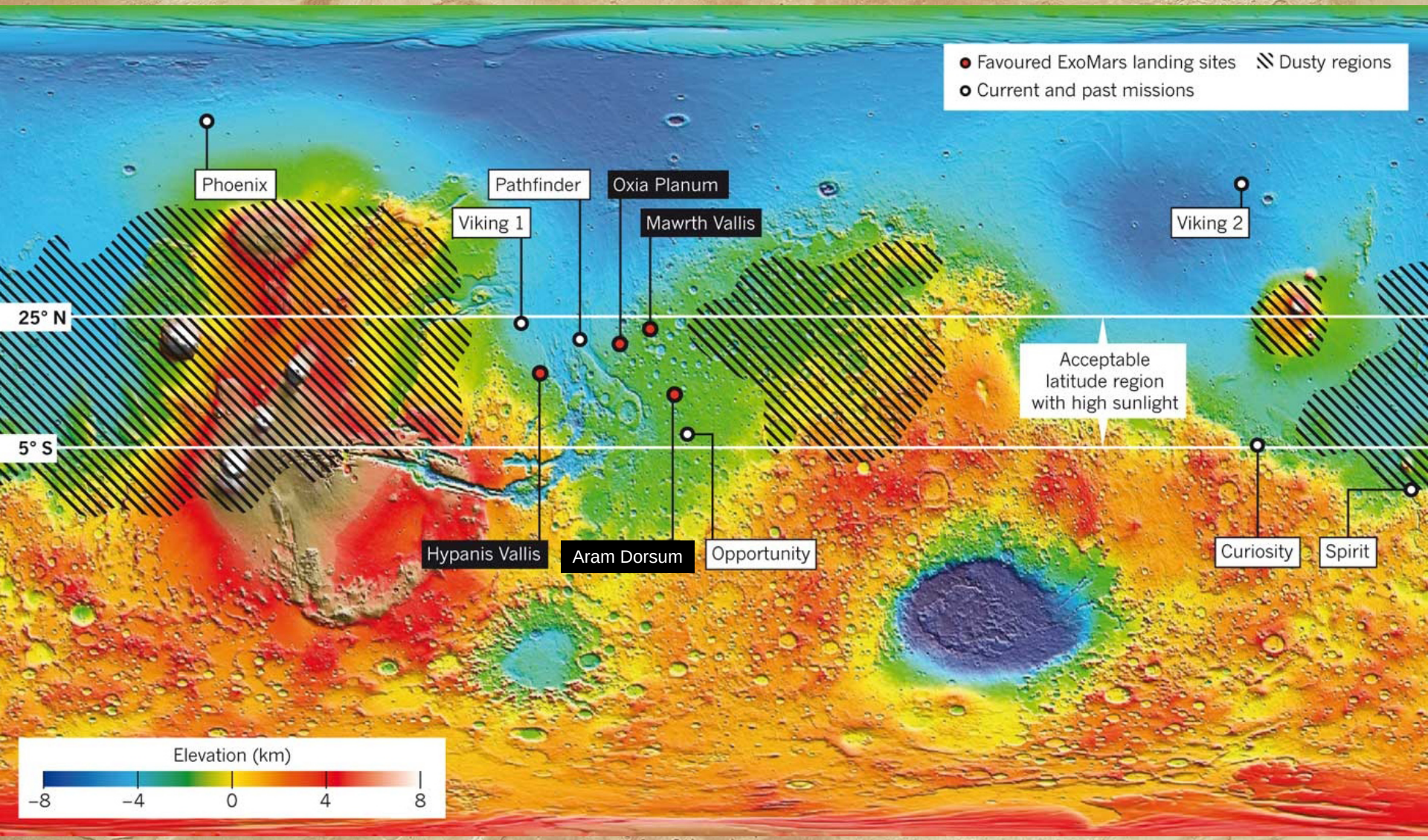
Target Distribution

The ellipse is 104 km x 19 km: We need targets everywhere !!!

- The rover nominal mission is 218 sols.
- During this time, the rover will likely travel in the order of 1.5–2.5 km.
- All other things being equal, we rather spend the time doing science rather than long traverses (characterising the local geology, drilling, and analysing samples).
- How likely is it that we can land on, or easily access an interesting location with many suitable outcrops?
- Respecting engineering requirements on solar illumination (latitude), altitude (< -2km), surface slopes, surface roughness/rock size distribution.

Credit: Hebes Chasma, MEX/HRSC

Candidate Landing Sites



Credit: Mamers Valles, MEX/HRSC

- **Three sites remain**
  - Oxia Planum has been recommended for a 2018 launch
  - In case of a 2020 launch, a second candidate site will be considered from between Mawrth Vallis and Aram Dorsum.

Oxia Planum

- Extensive exposures rich in Fe/Mg-phyllosilicates, (seen by both OMEGA and CRISM).
- Layered rocks, likely with clay-rich deposits
- Ancient crust (> 4 Ga) with intense erosion until 3.6 Ga ago.
- Includes more recent fluvial-related morphologies (valleys/delta)

Mawrth Vallis

- Phyllosilicates in light-toned, finely layered deposits (~1 m thickness)
- Large, stable aqueous system.
- Compositionally diverse outcrops over large surfaces, indicating multiple, varied wet environments.
- Highest degree of aqueous alteration identified so far on Mars.
- Ancient deposition and alteration (~4.0 Ga).
- Material of interest has been buried under a dark cap unit that has only recently been eroded away.

Aram Dorsum

- Layered sedimentary rocks with a prominent inverted channel ridge (> 80-km long).
- Mixture of sedimentary deposits in the area suggest that the inverted channel system has been exhumed only relatively recently.
- Ancient (~4.0 Ga) age for the alluvial system.

Credit: Mamers Valles, MEX/HRSC

ESA's SPACE EXPLORATION STRATEGY

B. PATTI
Directorate of Human Spaceflight and Robotic Exploration

IMEPAG 2-3
March 2016

European Space Agency

STRATEGIC FRAMEWORK
ESA SPACE EXPLORATION STRATEGY

ESA STRATEGY
Adopted at CM14

Destination-based

Mission focused

Enabled through partnerships

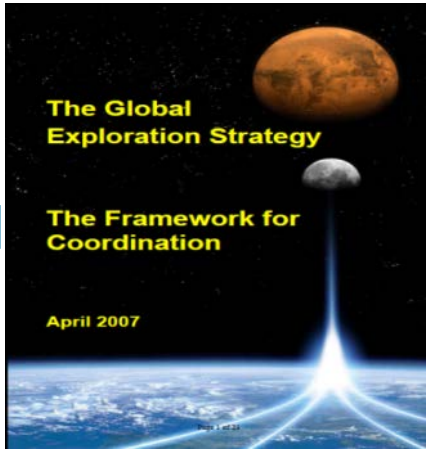
Mars long-term goal

Global endeavour

Step-wise approach

ISECG GER
Released 2013

GES
Released 2007



Full Consistency

Full Consistency

MOON SUSTAINABLE EXPLORATION

ESA DG Vision for sustained lunar activity, based on new and open governance scheme and driven by society at large

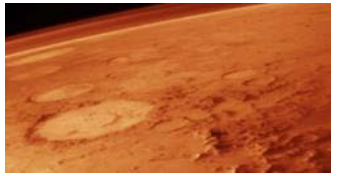
IECS

Cis-lunar habitat, as a common next step of the ISS partnership, open to new Partners, enabling human exploration of Moon, Asteroids and Mars

OVERVIEW
ESA SPACE EXPLORATION STRATEGY

Exploration driven robotic missions

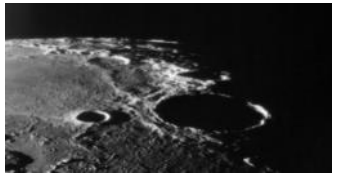
Participate in NASA-led journey to Mars, long-term focus for R&D.



Cis-lunar Habitat

Common step of ISS partnership, open to new Partners, enabling sustained human exploration BLEO.

Secure surface access for robots and humans. Provide critical capabilities (communication, power, resources). Integrate human and robotic assets for increasing mission performance.



Moon Exploration

Foster broad participation, public and private, and establish open governance structure.

ISS

Secure participation up to 2024.

User-driven LEO Exploitation

Diversification of LEO platforms post ISS.
Strategic Partnership with private sector.
Partnership with CMSA (integrate China into multi-lateral scenario).

ESA Mission Roadmap (notional)

15 20 25 30

ExoM 1

ExoM 2

Phobos SR

NASA

NASA S.C.

ESM 1

ESM 2

ESM 3

ESM 4

ESM 5..

Cis-Lunar Habitat

L. Glob

L. Resurs

Joint Precursor Campaign

Human Surface Ops

ISS

Chinese Station

Post ISS Platform – Human tended

IXV / Pride

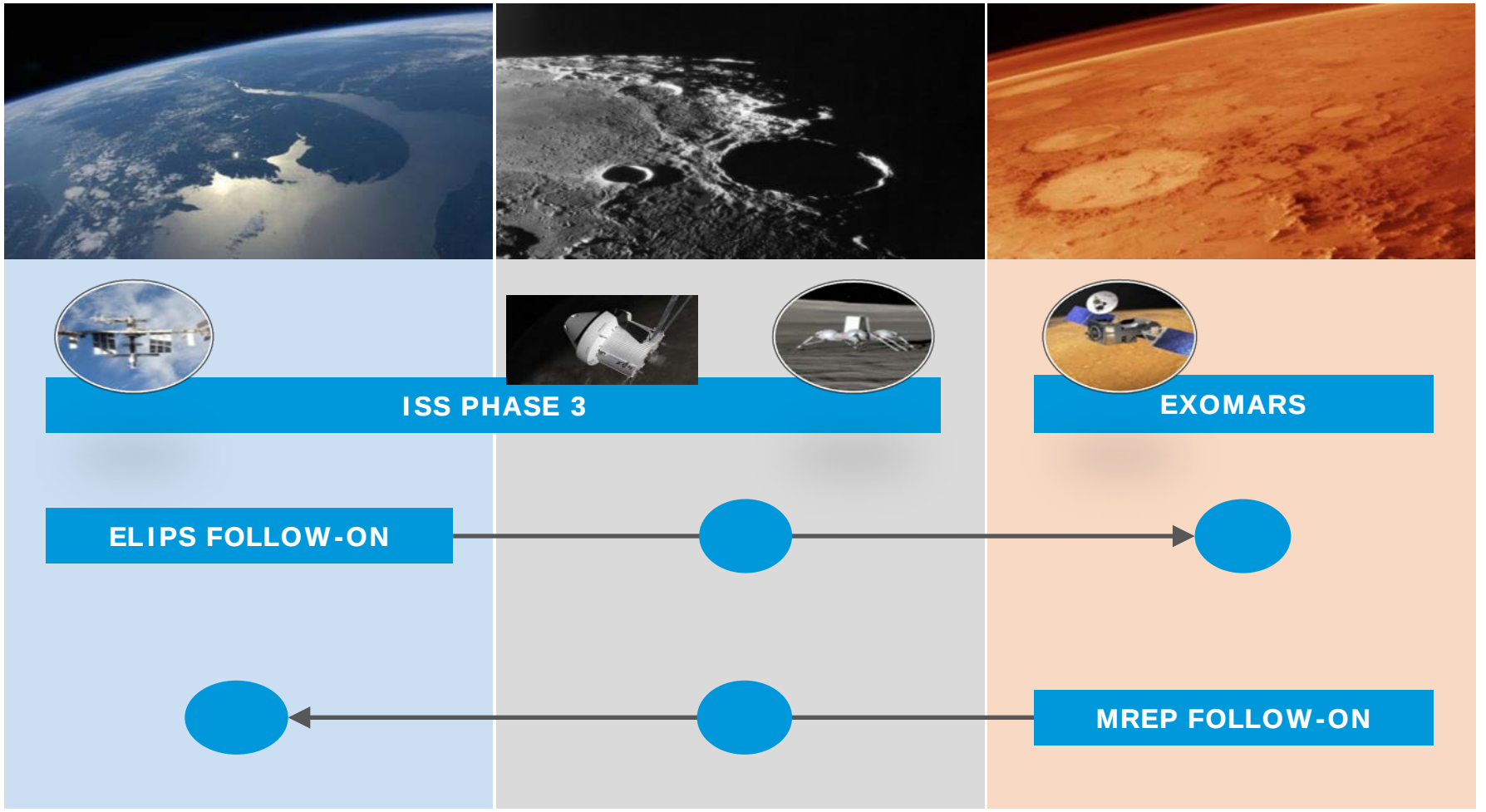
PROGRAMMATIC FRAMEWORK / CM16

ESA SPACE EXPLORATION STRATEGY

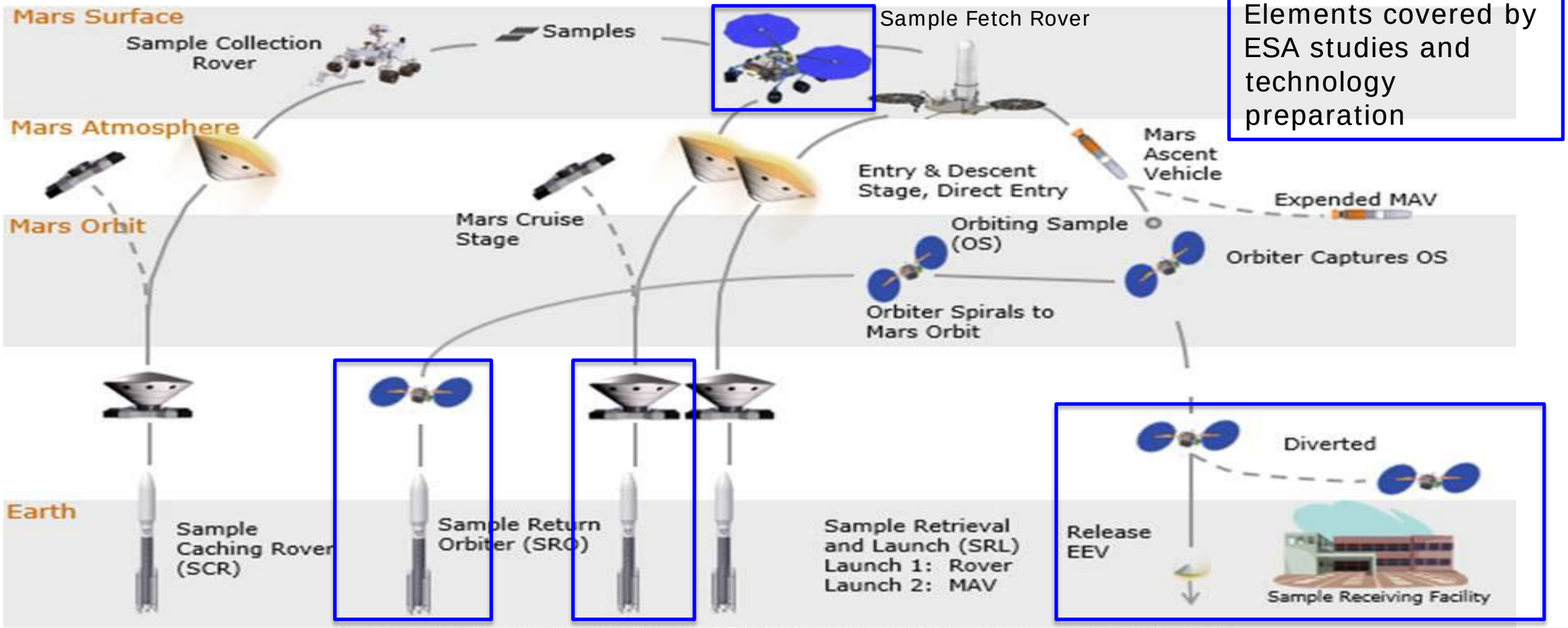
ISS/ Mission implementation and operations (including products for Luna 27 and strategic partnership with private sector)
Phase B2/C/D/E

Utilisation for benefits of humanity and preparation of human exploration

Technology & Mission Definition (post ExoMars and Luna 27)
Phase A/B1



MARS SAMPLE RETURN
(4+1 ARCHITECTURE)



Elements covered by ESA studies and technology preparation

Note: Sample Return Landers (SRL) and Sample Return Orbiter (SRO) can be launched in either order

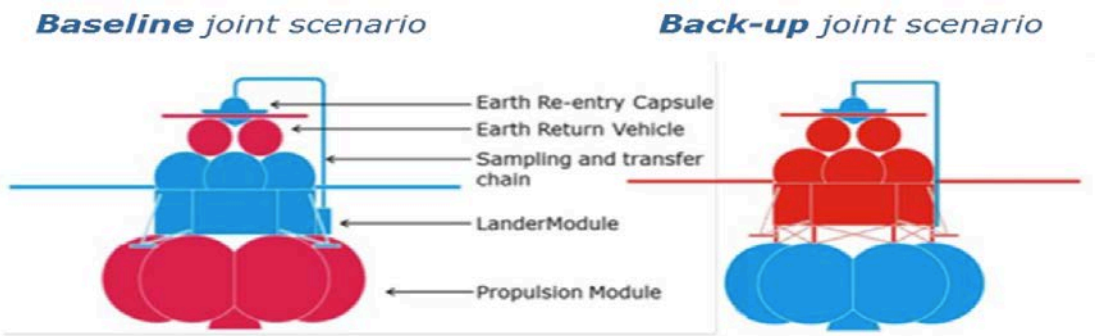
Phobos Sample Return – Phase A system studies

Prime objective: To return 100g of Phobos regolith to Earth and validate technologies for future sample return missions.

- Parallel industrial studies started in mid-2015 and are due to complete in summer 2016
- 3 configurations are being considered
  - Joint ESA - Russia baseline
  - Joint ESA - Russia backup
  - ESA standalone
- Launch opportunities between 2024 and 2028
- Return of capsule to Earth between 2027 and 2031

Phobos Sample Return – Phase A studies

- The Phobos Sample Return mission consists of four elements:
  - Propulsion Module (PM)
  - Landing Module (LM)
  - Earth Return Vehicle (ERV)
  - Earth Re-entry Capsule (ERC)



Joint baseline scenario: ESA is responsible for the LM and the ERC. PM, ERV and the launcher (Proton-M) are under ROSCOSMOS responsibility.

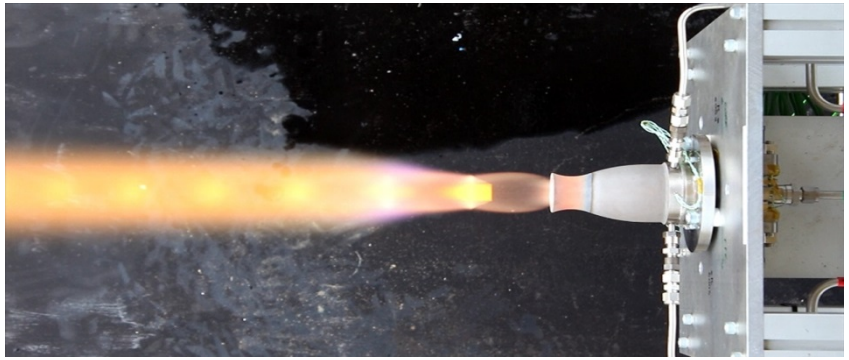
Joint backup scenario: ESA is responsible for the PM and the ERC. LM, ERV and the launcher are under ROSCOSMOS responsibility.

ESA-standalone scenario: ESA is responsible for all elements including launcher (Ariane 5)

The sample acquisition system and ERC are under ESA responsibility in all scenarios.

ESA Mars Technology investments - Buying down the risk on Mars Sample Return

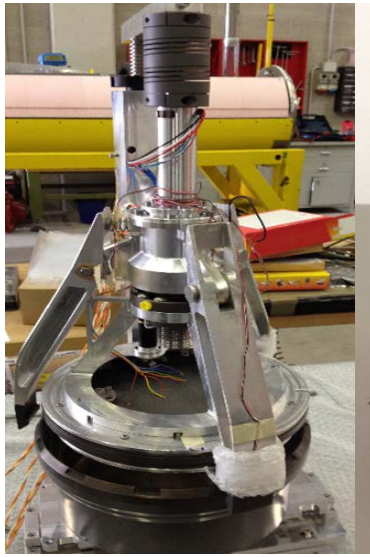
Earth Return Capsule mock-up for aerodynamic stability testing. Image credit: ESA/Vorticity (CH)

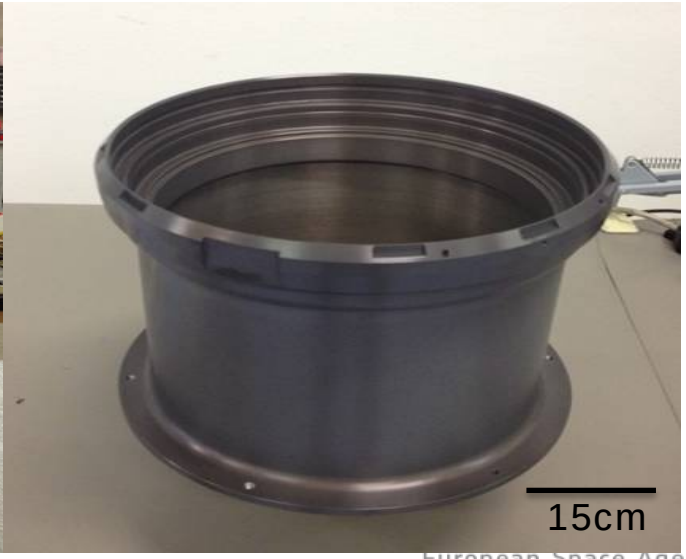


Hot-fire test of a **High Thrust Apogee Engine** for a Sample Return Orbiter Image credit: ESA/MOOG (UK)

Orbiting sample capture mechanism for the Mars Sample Return Orbiter. Image credit: ESA/Selex-Galileo(IT)

Biocontainer that will contain the Mars sample cache and protect it during the return and landing on Earth. Credit: ESA/Selex-Galileo(IT)





esa
THANK YOU
European Space Agency