The ExoMars Program 2016-2018

Elements of the ExoMars programme 2016-2018

Credit: ESA

The European Space Agency (ESA) has established the ExoMars program to investigate the Martian environment and to demonstrate new technologies paving the way for a future Mars sample return mission in the 2020's.

Two missions are foreseen within the ExoMars program: one consisting of an Orbiter plus an Entry, Descent and Landing Demonstrator Module, to be launched in 2016, and the other, featuring a rover, with a launch date of 2018. Both missions will be carried out in cooperation with Roscosmos.

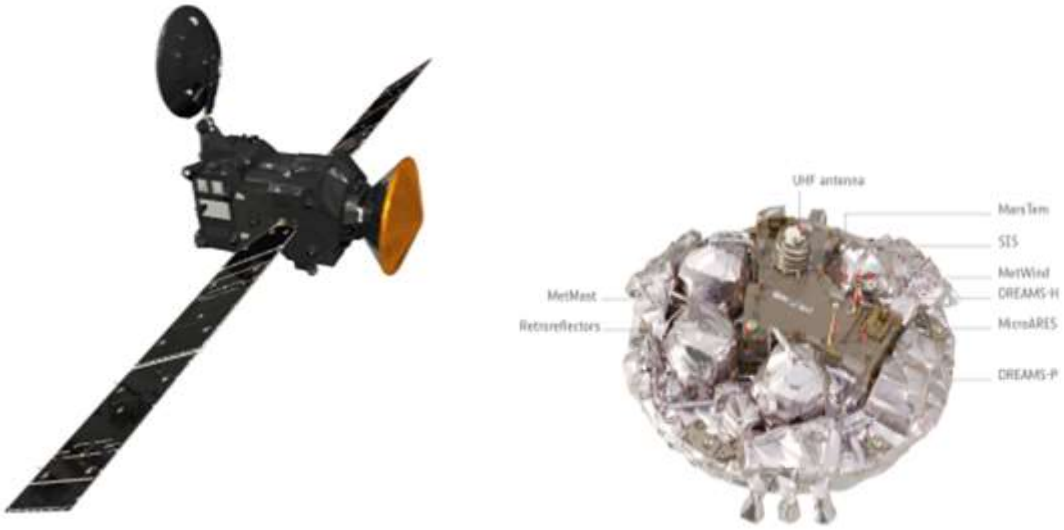
The ExoMars program will demonstrate a number of essential flight and in-situ enabling technologies that are necessary for future exploration missions, such as an international Mars Sample Return mission. These include:

- Entry, descent and landing (EDL) of a payload on the surface of Mars;
- Surface mobility with a rover;
- Access to the subsurface to acquire samples; and
- Sample acquisition, preparation, distribution and analysis.

At the same time a number of important scientific investigations will be carried out, for example:

- Search for signs of past and present life on Mars;
- Investigate how the water and geochemical environment varies; and
- Investigate Martian atmospheric trace gases and their sources.

ExoMars Trace Gas Orbiter and Schiaparelli Mission (2016)



ExoMars 2016: Trace Gas Orbiter and Schiaparelli. Credit: ESA/ATG medialab

The first mission of the ExoMars program, scheduled to arrive at Mars in 2016, consists of a Trace Gas Orbiter plus an entry, descent and landing demonstrator module, known as Schiaparelli. The main objectives of this mission are to search for evidence of methane and other trace atmospheric gases that could be signatures of active biological or geological processes and to test key technologies in preparation for ESA's contribution to subsequent missions to Mars.

The Orbiter and Schiaparelli will be launched together in March 2016 on a Proton rocket and will fly to Mars in a composite configuration. By taking advantage of the positioning of Earth and Mars the cruise phase can be limited to about 7 months, with the pair arriving at Mars in October. Three days before reaching the atmosphere of Mars, Schiaparelli will be ejected from the Orbiter towards the Red Planet. Schiaparelli will then coast towards its destination, enter the Martian atmosphere at 21 000 km/h, decelerate using aerobraking and a parachute, and then brake with the aid of a thruster system before landing on the surface of the planet. From its coasting to Mars till its landing, Schiaparelli will communicate with the Orbiter. Once on the surface, the communications of Schiaparelli will be supported from a NASA Relay Orbiter. The ExoMars Orbiter will be inserted into an elliptical orbit around Mars and then sweep through the atmosphere to finally settle into a circular, approximately 400-km altitude orbit ready to conduct its scientific mission.

Trace Gas Orbiter - Searching for signature gases in the Martian atmosphere

The Orbiter spacecraft is designed by ESA, while Roscosmos provides the launch vehicle. A scientific payload with instruments from Russia and Europe will be accommodated on the Orbiter to achieve its scientific objectives. The Orbiter will perform detailed, remote observations of the Martian atmosphere, searching for evidence of gases of possible biological importance, such as methane and its degradation products. The instruments onboard the Orbiter will carry out a variety of measurements to investigate

the location and nature of sources that produce these gases. The scientific mission is expected to begin in December 2017 and will run for five years. The Trace Gas Orbiter will also be used to relay data for the 2018 rover mission of the ExoMars programme and until the end of 2022.

Schiaparelli: an entry, descent and landing demonstrator module testing critical technology for future missions

Schiaparelli, the ExoMars entry, descent and landing demonstrator module will provide Europe with the technology for landing on the surface of Mars with a controlled landing orientation and touchdown velocity. The design of Schiaparelli maximizes the use of technologies already in development within the ExoMars program These technologies include: special material for thermal protection, a parachute system, a radar Doppler altimeter system, and a final braking system controlled by liquid propulsion.

Schiaparelli is expected to survive on the surface of Mars for a short time by using the excess energy capacity of its batteries. The science possibilities of Schiaparelli are limited by the absence of long term power and the fixed amount of space and resources that can be accommodated within the module; however, a set of scientific sensors will be included to perform limited, but useful, surface science.

ExoMars 2016 Mission Phases Overview	
Launch Period	14-25 March 2016
Schiaparelli – Trace Gas Orbiter separation	16 October 2016
Trace Gas Orbiter insertion into Mars orbit	19 October 2016
Schiaparelli enters Martian atmosphere and lands on the target site	19 October 2016
Schiaparelli science operations	19 October - 23 October 2016 (to be confirmed)
Trace Gas Orbiter changes inclination to science orbit (74°)	December 2016
Apocentre reduction manoeuvres (from the initial 4-sol orbit to a 1-sol orbit)	December 2016
Aerobraking phase (Trace Gas Orbiter lowers its altitude to 400 km orbit)	January 2017 - December 2017
Trace Gas Orbiter science operations begin. (In parallel, TGO will start data relay operations to support NASA landers on Mars.)	December 2017
Superior solar conjunction (critical operations are paused while the Sun	11 July - 11 August

is between Earth and Mars)	2017
Start of the Trace Gas Orbiter data relay operations to support communications for the rover mission and for the surface science platform	15 January 2019
End of Trace Gas Orbiter mission	December 2022

ExoMars Mission (2018)

ESA's ExoMars Rover. Credit: ESA

The 2018 mission of the ExoMars programme will deliver a European rover and a Russian surface platform to the surface of Mars. A Proton rocket will be used to launch the mission, which will arrive to Mars after a nine-month journey. The ExoMars rover will travel across the Martian surface to search for signs of life. It will collect samples with a drill and analyse them with next-generation instruments. ExoMars will be the first mission to combine the capability to move across the surface and to study Mars at depth.

During launch and cruise phase, a carrier module (provided by ESA) will transport the surface platform and the rover within a single aeroshell. A descent module (provided by Roscosmos with some contributions by ESA) will separate from the carrier shortly before reaching the Martian atmosphere. During the descent phase, a heat shield will protect the payload from the severe heat flux. Parachutes, thrusters, and damping systems will reduce the speed, allowing a controlled landing on the surface of Mars.

After landing, the rover will egress from the platform to start its science mission. The primary objective is to land the rover at a site with high potential for finding well-preserved organic material, particularly from the very early history of the planet. The rover will establish the physical and chemical properties of Martian samples, mainly from the subsurface. Underground samples are more likely to include biomarkers, since the tenuous Martian atmosphere offers little protection from radiation and photochemistry at the surface.

The drill is designed to extract samples from various depths, down to a maximum of two metres. It includes an infrared spectrometer to characterise the mineralogy in the borehole. Once collected, a sample is delivered to the rover's analytical laboratory, which will perform mineralogical and chemistry determination investigations. Of special interest is the identification of organic substances. The rover is expected to travel several kilometres during its mission.

The ExoMars Trace Gas Orbiter, part of the 2016 ExoMars mission, will support communications. The Rover Operations Control Centre (ROCC) will be located in Turin, Italy. The ROCC will monitor and control the ExoMars rover operations. Commands to the Rover will be transmitted through the Orbiter and the ESA space communications network operated at ESA's European Space Operations Centre (ESOC).