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Media kit

→ EUROPE'S NEW ERA OF MARS EXPLORATION

ExoMars 2016: analysing atmospheric gases for signs of active biological or geological processes on Mars, and testing key landing technologies

The ExoMars 2016 mission consists of the Trace Gas Orbiter (TGO) and an entry, descent and landing demonstrator module, known as Schiaparelli.

TGO will make a detailed inventory of Mars' atmospheric gases, with particular attention to rare gases like methane. There have been tentative and fleeting detections of methane on Mars since 2003, which implies that there is an active, current source. By monitoring its geographical and seasonal dependence, TGO will help to determine whether the methane stems from a geological or biological source.

TGO will also image the martian surface, and search for water ice on and just below the surface of the planet.

Schiaparelli will test key technologies in preparation for ESA's contributions to subsequent missions to Mars.

The orbiter will also act as a communications satellite for present and future missions to the Red Planet.

ExoMars is a joint endeavour between ESA and Russia's Roscosmos space agency.

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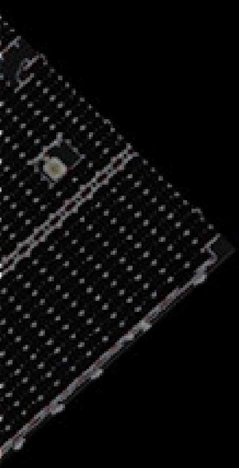

Why Mars?

There is ample evidence that liquid water existed and flowed on the surface of Mars in the past and may even do so intermittently on the surface today. On Earth, water is fundamentally linked to life, and so the obvious question arises: if there was water on Mars, has there ever been life? This remains one of the biggest unanswered questions in martian exploration and one that lies at the heart of the ExoMars programme.

As one of Earth's nearest planetary neighbours, Mars has been a primary target for international robotic exploration efforts since the 1960s. Numerous missions from the U.S., Soviet Union, India, Japan, and Europe have flown to the Red Planet, with varying degrees of success, to study the planet, and to understand the similarities and differences between it and Earth.

The present-day surface of Mars is dry, but it is now clear that there were significant amounts of liquid water there in the distant past. The best possible opportunity for the emergence of life on Mars was in the first billion years after the planet had formed, when it was much warmer and wetter than today – conditions similar to those on the young Earth.

Thus, in principle, there could still be life on Mars, however, it is unlikely to be on the surface, since the surface is subject to harsh radiation due to the planet's very thin atmosphere. But there might be evidence of past life preserved underground. Sampling the subsurface down to a depth of 2 metres to search for such biomarkers will be a key goal of the ExoMars rover, scheduled for launch in 2018.

In the meantime, the ExoMars Trace Gas Orbiter, to be launched in March 2016, will follow a different approach. One of its key goals is to follow up on indications from previous space missions and ground-based observations that small amounts of methane exist in the atmosphere of Mars. Methane is of particular interest because on Earth it is mostly produced by biological processes. In particular, TGO will search for evidence, including spatial and seasonal changes, that could help distinguish between production by geological or biological activity on the planet.

What is ExoMars 2016?

Following ESA's successful Mars Express mission, launched in 2003 and still in operation, the ExoMars programme is the next step for Europe in the robotic exploration of Mars. This programme was established to address the long-standing question of whether life ever existed on Mars.

A cooperation between the European Space Agency (ESA) and Roscosmos, ExoMars currently comprises two missions.

The first, called ExoMars 2016, is scheduled for launch in March 2016 and consists of the Trace Gas Orbiter (TGO) and an Entry, descent, and landing Demonstrator Module (EDM), also known as Schiaparelli.

The second ExoMars mission is planned for launch in 2018 and comprises a rover and surface science platform.

The ExoMars 2016 TGO will search for signs of life from Mars orbit and for evidence of water-ice deposits on and just beneath the surface.

One of its key goals is to follow up on indications from previous space missions and ground-based observations that small amounts of methane exist in the atmosphere of Mars. Methane should be destroyed by ultraviolet radiation on timescales of hundreds of years, and thus it must still be produced today.

Possible sources of methane are biological, from primitive microbes similar to methanogens on Earth, and geological, linked to processes taking place in the presence of hot liquid water beneath the martian surface.

TGO will map the spatial and temporal distribution and isotopic make-up of atmospheric methane and other trace gases to help distinguish between the different origin scenarios.

TGO has the sensitivity necessary to analyse the planet's gases such as methane in much more detail than any previous or current mission at Mars. It will also image and characterise features on the martian surface that may be related to trace-gas sources such as volcanoes.

These science goals will be addressed using four science instruments.

Spectrometers on ACS (**A**tmospheric **C**hemistry **S**uite) and NOMAD (**N**adir and **O**ccultation for **M**ars **D**iscovery), spanning a range of UV, visible, and IR wavelengths, are charged with taking a detailed inventory of Mars' atmospheric trace gases, and will monitor seasonal changes in the atmosphere's composition and temperature in order to create detailed atmospheric models. The instruments also have the capability to discover minor atmospheric constituents yet to have been detected.

To complement these measurements, CaSSIS (**C**olour **a**nd **S**tereo **S**urface **I**maging **S**ystem) will image and characterise features on the martian surface that may be related to trace-gas sources such as volcanoes.

Meanwhile, FREND (**F**ine **R**esolution **E**pithermal **N**eutron **D**etector) will map hydrogen down to a depth of one metre to reveal deposits of water-ice hidden just below the surface, which, along with locations identified as sources of the trace gases, could influence the choice of landing sites of future missions.

TGO will also act as a data relay for the ExoMars 2018 rover, and for NASA rovers.

The second part of the ExoMars 2016 mission is the entry, descent, and landing demonstrator module, Schiaparelli, which will be launched mated to the TGO, and then separate from it shortly before their arrival at Mars.

The main goal of this mission element is to demonstrate that Europe has the essential technology required to make a controlled landing of a probe on Mars, which in turn is a prerequisite for any further exploration of the planet. It also includes a limited set of scientific instrumentation to probe the martian atmosphere during the descent and shortly after landing.

Mission at a glance
Quick reference mission facts for ExoMars 2016

Launch: 14 March 2016 at 09:31 UTC (10:31 CET) on a Russian Proton-M/Breeze-M launch vehicle from the Baikonur cosmodrome in Kazakhstan. In case of delays, there are further opportunities for launch within the window that remains open until 25 March.

Arrival at Mars: 19 October 2016

Distance travelled: The spacecraft will have travelled 496 million km between launch and Mars orbit insertion.

Launch mass: 4332 kg (including 112 kg science payload and 600 kg Schiaparelli)

Trace Gas Orbiter dimensions: 3.5 m x 2 m x 2 m with solar wings spanning 17.5 m tip-to-tip

Trace Gas Orbiter payload: Atmospheric Chemistry Suite (ACS); Colour and Stereo Surface Imaging System (CaSSIS); Fine Resolution Epithermal Neutron Detector (FREND); Nadir and Occultation for Mars Discovery (NOMAD)

Trace Gas Orbiter nominal mission: The orbiter arrives at Mars in October 2016 and will enter a highly elliptical orbit that takes four martian days to complete one revolution. The distance from the planet's surface will vary from about 300 km to 96 000 km. Aerobraking manoeuvres between January 2017 and November 2017 will bring the orbiter into a circular orbit at 400 km above the martian surface. Science operations begin in December 2017 and continue for two years.

Schiaparelli dimensions: approximately 1.65 m diameter (2.4 m with heatshield) and 1.8 m high.

Schiaparelli engineering and science packages: DREAMS instruments for surface science; COMARS+ package to characterise heatshield response during descent; atmospheric studies with AMELIA, using engineering sensors; INRRI for retroreflection experiments.

Schiaparelli entry, descent and landing: TGO will eject Schiaparelli on 16 October at 14:42 UTC. Schiaparelli will land on Mars three days later.

Landing site: Meridiani Planum. Targeting a landing ellipse centred at 6º West and 2º South, and measuring about 100 km East-West and 15 km North-South.

Schiaparelli mission duration: several days, powered by internal batteries

Ground communications: On the day of launch, ASI's 2 m antenna at Malindi, Kenya, and ESA's 15 m ground stations at Maspalomas, Spain and Kourou, French Guiana will be used to communicate with TGO. During the journey to Mars and while in orbit at the planet, TGO will communicate with Earth via ESA's Malargüe ground station in Argentina and New Norcia ground station in Australia. TGO uses a 65 W X-band system with the 2.2-m-diameter high-gain antenna and 3 low-gain antennas for communication with Earth; TGO also carries Electra UHF band transceivers (provided by NASA) with a single helix antenna for communication with surface rovers and landers. Communications with Schiaparelli will be supported by ESA's Mars Express and by a NASA relay orbiter.

Name: The name ExoMars reflects the goals of the mission: to search for evidence of exobiology – the possible existence of life beyond Earth – on Mars.

ESA and Roscosmos contributions: ExoMars is a cooperation between the European Space Agency (ESA) and Roscosmos, the Russian space agency. The programme comprises two missions: one launching in March 2016 and consisting of the Trace Gas Orbiter (TGO) and Schiaparelli, an entry, descent and landing demonstrator module, and a second (planned for launch in 2018) comprising a rover and surface science platform. Roscosmos is providing the Proton rockets to launch both missions to Mars, along with contributions to the scientific payload (two of the four science instrument packages of the TGO are European-led and two are Russian-led). The 2018 mission comprises a European-led rover and a Russian-led surface science platform. NASA also contributes some equipment and scientific payload elements to the missions.

Industrial contributions: The prime contractor for the ExoMars programme is Thales Alenia Space Italia. Contractors from many ESA Member and Cooperating States within Europe have contributed. These are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Portugal, Spain, Sweden, the Netherlands, Norway, Poland, Switzerland, and the United Kingdom. Participating countries outside Europe are Russia, the United States, Canada, and Israel.

See Appendix C for a table of mission milestones.

Science with the Trace Gas Orbiter

Any gas that makes up less than 1% by volume of a planet's atmosphere is known as a trace gas. In the Earth's atmosphere, methane is a trace gas, comprising around 1.8 parts per million by volume (0.00018%). Other trace gases on Earth include argon, carbon dioxide, and neon.

In the much lower density martian atmosphere, methane comprises around 10 parts per billion by volume. Other trace gases on Mars include water vapour, nitrogen oxides, and acetylene.

The great majority of Earth's methane is released as a consequence of biological processes. Most is linked to anaerobic single-celled organisms known as methanogens that are involved in the decomposition of biomass, for example in the guts of ruminants or in swamps. Some of this methane is being produced today, while some is trapped and perhaps released from the permafrost. A much smaller fraction of Earth's methane has a geological origin, whether from natural gas, or volcanic and hydrothermal activity.

Because of the key role biology plays in Earth's methane production, it naturally raises the question of whether the methane on Mars has a similar origin, thus whether there is a form of life currently producing it on Mars. An alternative source of the methane could be 'serpentinisation', a geological process that takes place when hot water reacts with rocks that contain a magnesium iron silicate mineral called olivine. This could be taking place deep under the martian surface, perhaps in combination with warmer, volcanic environments.

Methane on Mars is expected to have a relatively short lifetime – around 400 years – because it is broken down by ultraviolet light from the Sun. Atmospheric mixing should quickly lead to a more or less uniform background concentration. But previous measurements by ESA's Mars Express mission and ground-based observatories suggest that there are seasonal variations in the methane abundance, and that concentrations vary with location and time. If this is true, there must be localised active sources to replenish the supply and, at the same time, a relatively quick way of removing it in order to account for the apparent rise and fall in the measurements.

Understanding the processes at play is the goal of the ExoMars Trace Gas Orbiter (TGO).

TGO has the capability to detect and analyse methane and other trace gases a thousand times better than all previous measurements, even if methane is present in low concentrations.

Furthermore, it will be able to detect key differences in molecules of methane and water that can show whether they were formed by biological or geological activity. Measurements of methane on Earth suggest that methane originating from biological and geological processes have a distinctive isotopic signature, and thus TGO's measurements will be key in constraining the origin and history of these species on Mars.

The role of Schiaparelli

Landing and operating on the surface of Mars is challenging. While it has been attempted on several occasions since the late 1960s, it has only been successfully achieved seven times. As part of the roadmap towards possible future Mars sample return missions and beyond, a core goal of the ExoMars programme is to develop and prove the technologies necessary for safely landing and operating on the planet.

An element of the ExoMars 2016 mission, the Entry, descent, and landing Demonstrator Module (EDM), known as Schiaparelli, is aimed at proving the capability of ESA and European industry to perform a controlled landing on the surface of Mars.

The preparation for this mission enhances Europe's expertise and enables the testing of key technologies, which could be used in subsequent missions to Mars:

- Schiaparelli's aeroshell is covered with insulating tiles made of Norcoat Liège, a thermal ablative material composed of resin and cork. This can resist temperatures of up to 1850°C.

- Sensors on the rear cover of Schiaparelli (the COMARS+ package) will monitor how the module's external surface responds as it plummets through the atmosphere.

- A "disc-gap-band" parachute, with a 12-m-diameter canopy has been developed to slow Schiaparelli as it descends through the martian atmosphere.

- After the front cover of the heat shield has been jettisoned, the descent trajectory will be recorded by an on-board engineering camera (DECA) that will take images to provide engineering insight into the descent and landing phase.

- A Doppler radar altimeter and velocimeter will determine the height and speed with respect to the surface. This information will be used to guide the final phase of the module's descent when a braking system controls the descent until Schiaparelli is about 2m above the surface.

Developed to demonstrate entry, descent and landing technologies, Schiaparelli is only designed for a short operational lifetime after landing, but nevertheless offers limited, but useful, science capabilities.

A small meteorological station (DREAMS) will operate on the surface of Mars for a few days. DREAMS will measure local weather conditions at the landing site, such as temperature, humidity, pressure, dust opacity, wind speed, and wind direction. It will also perform measurements of the electrical properties of the martian atmosphere, the first time this has ever been done.

Scientists will also use the engineering measurements made by sensors on and inside Schiaparelli during the descent to conduct scientific investigations of Mars' atmosphere and surface. This experiment (AMELIA) will study some of the major properties of the martian atmosphere, such as density, pressure and temperature, from an altitude of about 130 km all the way down to the surface.

In addition, a simple camera (DECA) on Schiaparelli will take 15 monochrome images during the descent to provide engineering insight into the landing process and to help identify the actual landing location. However, it is not designed to take images from the surface. DECA is a repurposed flight spare of the visual monitoring camera used during the launch of ESA's Herschel and Planck satellites in 2009.

Finally, a compact array of laser retroreflectors, known as INRRI, is attached to the upward-facing surface of Schiaparelli. This can be used as a target for future Mars orbiters to laser-locate the module.

How and where will Schiaparelli land?

At 14:42 UTC on 16 October 2016, three days before arriving at Mars, the ExoMars 2016 Trace Gas Orbiter (TGO) and Schiaparelli will separate. Fifteen minutes later, the module will enter hibernation to conserve energy as it coasts towards the planet.

Twelve hours after separation, the TGO will perform a course correction to avoid entering the atmosphere, and will continue towards Mars orbit insertion.

On 19 October, about six hours before reaching the martian atmosphere, Schiaparelli will briefly exit hibernation to warm up some of the critical systems on-board.

About one hour before hitting the atmosphere, it will emerge for the last time from hibernation and begin to prepare the on-board systems for the critical events to follow.

The entry, descent, and landing sequence will be carried out autonomously.

On 19 October, the spacecraft will be about 175 million km from Earth and it will take 9 mins 46 s for signals to reach Earth from Mars. The time elapsed between Schiaparelli entering the atmosphere and landing will be less than six minutes, so no intervention would be possible.

Schiaparelli will enter the atmosphere at an altitude of about 121 km and a speed of nearly 21 000 km/h. In the three to four minutes that follow, it will be slowed down by the increasing atmospheric drag, with the front shield of the aeroshell bearing the brunt of the heating. This will slowly char and ablate, allowing the absorbed heat to be carried away from the rest of the spacecraft.

At roughly 11 km above the surface, Schiaparelli's speed will have decreased to 1700 km/h and a supersonic parachute will be deployed. The parachute canopy will unfurl in less than a second, and 40 seconds later, after oscillations have died down, the front shield of the aeroshell will be jettisoned. The parachute will slow Schiaparelli down to around 250 km/h, and then, at 1.2 km from the surface, the back half of the aeroshell, with the parachute attached to it, will also be jettisoned. It will be drawn rapidly away from Schiaparelli, which will now be completely free of the aeroshell that had kept it safe *en route* to Mars.

One second later, Schiaparelli will activate its nine hydrazine-powered thrusters to control its speed. An on-board radar system will continuously measure the height above the surface. At an altitude of around two metres, Schiaparelli will briefly hover. Then its engines will cut out, leaving it to fall the remaining distance to the surface.

The touch-down speed will be a few metres per second, and the impact force will be absorbed by a crushable structure on the underside of the lander, similar to the crumple zone in a car The entire entry, descent, and landing sequence will take less than 6 minutes.

See Appendix D for a timeline of key events on 19 October.
An infographic outlining the entry, descent and landing sequence is available here: exploration.esa.int/mars/edl-sequence/

Schiaparelli will touchdown in a relatively smooth, flat region called Meridiani Planum. The landing ellipse, centred at 6° West and 2° South, measures about 100 km East-West and 15 km North-South. The targeted area is close to the landing site of NASA's Opportunity rover (2° South, 354° East).

The landing is controlled, not guided, and Schiaparelli has been designed to be capable of landing on a terrain with rocks as high as 40 cm and slopes as steep as 12.5°.

As well as being relatively flat and smooth, Meridiani Planum also lies at relatively low elevation, meaning that the atmosphere is sufficiently thick to allow Schiaparelli's heat shield to reduce the module's velocity, to deploy its parachute, and to use the firing of its thrusters to ensure a soft and controlled landing.

The journey to Mars

On 14 March 2016 at 09:31 UTC (10:31 CET) a Russian Proton-M/Breeze-M launcher will lift off from the Baikonur cosmodrome in Kazakhstan, carrying the ExoMars 2016 spacecraft: the Trace Gas Orbiter and the Entry, descent and landing Demonstrator Module (EDM), known as Schiaparelli.

As the launcher orbits Earth, its three stages will fire sequentially to boost the spacecraft until it reaches an altitude of just over 4900 km and, at 20:13 UTC, the Breeze-M upper stage ejects the Trace Gas Orbiter with a velocity of 33 000 km/h with respect to Earth. This is the moment when ExoMars 2016 departs for Mars on an interplanetary transfer orbit.

At 21:28 UTC (12 hours after launch), the first signals from the Trace Gas Orbiter will be received by ASI's Malindi ground station in Kenya, and relayed to the European Space Operations Centre (ESOC), ESA's mission control, in Darmstadt, Germany.

Once contact has been established with the spacecraft, command and control will be taken over by ESA's flight control team at ESOC. One of the first tasks will be to determine, using radiometric data gathered via ESA's 15 m Maspalomas ground station in Spain, TGO's precise orbital trajectory. In addition to Malindi and Maspalomas, ESA's ground station at Kourou, French Guiana will also be on duty during this phase.

Subsequently, as the craft embarks on its journey to Mars, tracking and telecommanding duties are handed over to ESA's 35-m-diameter deep-space tracking stations at Malargüe, Argentina, and New Norcia, Australia. Both are part of ESA's tracking station network. Known as ESTRACK, it is a global system of ground stations operated from ESOC.

During the first 6 weeks after launch the instruments and the spacecraft systems are 'commissioned'. In other words, they are checked by the instrument teams and the mission control teams at ESOC.

In early April, the NASA Electra radio transponder on-board TGO will be switched on and tested by a joint ESA-NASA team. This device will play a crucial role once TGO is in routine orbit at Mars, providing daily data relay services for NASA and ESA landers and rovers on the Martian surface.

After the commissioning phase, which will last until the end of June, TGO enters the cruise phase as it continues *en route* to Mars. At this stage, ground station passes are only scheduled three times weekly for routine checks to verify the health and functionality of TGO and Schiaparelli.

From mid-July to mid-August, teams at ESOC will conduct a series of navigation measurements known as 'delta-DOR', for Delta-differential One-Way Ranging. This technique uses signals from quasars – very bright, distant astronomical objects whose position is known with great accuracy – to correct the radio signals received from TGO, resulting in an extremely precise position determination. The spacecraft's position in space can be fixed on the order of just several hundred metres at a distance of 100 million km. Results from this delta-DOR campaign will be used to determine the location and trajectory of the Trace Gas Orbiter and to calculate the mid-course trajectory correction manoeuvre, to be performed on 28 July – a manoeuvre that will line the spacecraft up to intersect with Mars on 19 October.

Approaching 19 October, the work of the mission control teams becomes steadily more intense. ESA's ESTRACK ground stations start providing daily telecommanding passes. In the ten days before arrival, New Norcia and Malargüe ground stations will provide radio contact 24 hours a day. Engineers at ESOC will monitor the spacecraft and plan its complex orbital insertion and atmospheric entry activities.

On 16 October 2016 a series of critical arrival activities will be carried out.

The guidance, navigation and control system on Schiaparelli will be checked out, and its batteries will be charged for the final time before switching to internal power. Then, TGO will eject Schiaparelli, dispatching it on a three-day descent to the surface.

Prior to separation, TGO will perform a 'slew', rotating about its axes so that only its low-gain antenna will face Earth. As a result, ESA will enlist the support of NASA's 70m Deep Space Network (DSN) ground stations at Canberra, Australia, and Madrid, Spain, to listen for the spacecraft's signals as the module separates. Schiaparelli will be pushed away from TGO at a relative speed of just 37 cm/s, but this tiny push can be detected by the DSN stations. Fifteen minutes after separation, Schiaparelli will enter hibernation again, to conserve energy.

Schiaparelli will be dispatched on a direct intercept course toward Mars on track to enter the atmosphere and conduct the descent and landing sequence on 19 October.

About 12 hours after Schiaparelli has separated, the TGO will conduct a critical engine burn that will raise its trajectory to several hundred kilometres above the planet (otherwise, like Schiaparelli, TGO would also intersect the surface on 19 October). This manoeuvre will require the orbiter's engine to burn for a few minutes, and will line the craft up for a second critical burn on 19 October, lasting about 134 minutes, which will slow it sufficiently to be captured by Mars' gravity.

If for any reason Schiaparelli fails to separate from TGO on 16 October, there is a back-up separation slot on 17 October.

On 19 October, about six hours before atmosphere entry, Schiaparelli will emerge briefly from hibernation to warm up critical units. It will then hibernate again for five hours at which stage it exits hibernation for the last time to prepare for the entry, descent and landing sequence.

The details of the entry, descent and landing sequence are described elsewhere in this media kit. A table of key events on 19 October is given in Appendix D.

During Schiaparelli's entry, descent and landing phase on 19 October, ESA's Mars Express probe, which has been orbiting the Red Planet since 2003, will monitor and record signals from the module.

This procedure, called 'open-loop' recording, will enable Mars Express to detect critical events such as parachute deployment, heat shield jettisoning, touchdown, and start of operations on the surface, which will be relayed immediately to mission controllers at ESOC.

The amount of Schiaparelli signal data recorded by Mars Express will be kept small, so that the recorded information can be quickly relayed to Earth. On 19 October, signals will take 9 mins 46 s to travel from Mars to Earth. Receipt of this recording, about 1 hour after touchdown, will provide the first in situ confirmation of Schiaparelli's arrival and landing.

Schiaparelli's descent will also be recorded by the Giant Metrewave Radio Telescope (GMRT), located near Pune in India. GMRT comprises an array of 30 radio telescopes (each with a dish diameter of 45 m) operated by the National Centre for Radio Astrophysics, a part of the Tata Institute of Fundamental Research, Mumbai. It is one of the world's largest interferometric arrays.

To record Schiaparelli's signal across the 206 million kilometres between Earth and Mars on 19 October, the GMRT will be augmented with radio science equipment developed at NASA's Jet Propulsion Laboratory (JPL) for future Mars missions.
A joint JPL/GMRT team will record the descent signals, and make the recorded plot immediately available to mission controllers at ESOC, providing an additional confirmation of Schiaparelli's arrival.

Operating at Mars

ESA has been operating a spacecraft at Mars since the December 2003 arrival of Mars Express. With the ExoMars 2016 Trace Gas Orbiter and Schiaparelli, the Agency will embark on a series of operational firsts.

The Trace Gas Orbiter (TGO) launches in March 2016 and arrives at Mars seven months later. On 16 October, the TGO will release Schiaparelli, which will head towards the planet's surface to land 3 days later. After the module has been released the orbiter will change course to enter orbit around Mars. The initial orbit will be a highly elliptical one that takes four martian days to complete one revolution. Over the course of an orbit the altitude of TGO above the martian surface will vary between about 300 km to 96 000 km.

The first three months of operations will be standard for missions to Mars, but thereafter the innovative operational aspects begin.

In January 2017, the spacecraft will begin a lengthy period of adjustment to attain its ultimate science operations and radio-relay orbit. Between January and November 2017, the Trace Gas Orbiter will steadily lower itself, by aerobraking, to a circular, 400-km orbit. Although ESA spacecraft operators have experience of aerobraking at Venus it was under very different circumstances: for a shorter period of time, at the end of a mission rather than at the start, and for the purpose of reducing the altitude and allowing an exploration of previously uncharted regions of the Venusian atmosphere.

With ExoMars 2016, it will be the first time ESA uses aerobraking for an extended period to attain a science orbit around another body in our Solar System.

With the aerobraking, the TGO solar arrays will be used to generate tiny amounts of drag as the spacecraft flies through the martian atmosphere at very high altitudes. This will slow the craft and lower its orbit. While aerobraking takes time, it uses very little fuel and will itself provide scientific insight into the dynamics of Mars' atmosphere.

In addition to scientific investigations at Mars, the TGO will also play an important role for data relay. The Electra radio system on TGO is a telecommunications package provided by NASA that acts as a communications relay and navigation aid. It is composed of twin ultra-high frequency (UHF) radios and will provide communication links between rovers and landers on the martian surface and Earth.

While in orbit, the Trace Gas Orbiter will provide daily data relay services to NASA's Curiosity and Opportunity rovers currently on the surface, as well as to ESA's ExoMars 2018 rover. It will also support Russia's 2018 surface science platform and future NASA rovers. This continues the pattern of inter-agency cooperation in which, for example, ESA's Mars Express has been used routinely to monitor and track the arrival of NASA landers and rovers at Mars, while NASA ground stations have tracked European missions such as Rosetta and Mars Express.

Planetary protection for Mars missions

Humans now routinely venture beyond Earth and send spacecraft to explore other planets. Yet with this extraordinary ability comes great responsibility; we must ensure that we do not bring back anything harmful from other worlds. Similarly, we must make sure that we do not introduce terrestrial biological contamination to other planets and moons that have potential for past or present life.

Meeting these planetary protection constraints is not just an aspiration; it is a legal obligation. The Committee on Space Research (COSPAR) has formulated a planetary protection policy to guide compliance with the United Nations Outer Space Treaty.

ESA has adopted this policy and acts on behalf of its Member States to ensure that the requirements are met for all missions the Agency is flying or contributing to.

In practice, for some missions planetary protection sets limits for the level of acceptable microbiological contamination and for the probability of a spacecraft crashing on specific target bodies.

Mars is a primary target in the search for evidence of extraterrestrial life, past or present, and for this reason stringent planetary protection requirements apply.

To satisfy these requirements, for orbiters or for spacecraft performing flybys, a space agency must demonstrate one of two things. Either that there is a very small chance of the spacecraft crashing or impacting on its target world or that, in the event of a crash, the chance of biologically contaminating the planet is below a set limit.

For the ExoMars Trace Gas Orbiter, ESA have chosen to satisfy the impact probability constraint. The Agency has demonstrated that there is a less than 1 in 100 chance of an impact on the planet for the first 20 years after launch and less than 1 in 20 chance for the time period from 20 to 50 years after launch.

These assessments are made by evaluating the operational reliability of the mission, the flight hardware reliability, and the effects of the natural space environment such as micrometeoroids or Mars atmospheric variations. The launcher upper stage has also been included in these assessments to ensure that it does not impact Mars after separating from the spacecraft.

For a lander or rover the limits on the level of possible microbiological contamination are much more stringent. For Schiaparelli – the ExoMars 2016 entry, descent, and landing demonstrator module – the ExoMars project built a new cleanroom, in which the microbiological contamination could be strictly controlled during the assembly of the module at Thales Alenia Space in Italy.

When the module was assembled, it was transferred to the Thales Alenia Space premises at Cannes, France, for integration and testing. A portable 'clean tent' that could be used during these activities was set up in Cannes and later, when Schiaparelli was transferred to the launch site in Baikonur, the clean tent was transferred there too. In addition, the project has built two new microbiological laboratories to measure the microbiological contamination levels in the cleanrooms and on the flight system: one at Thales Alenia Space in Italy, and one at the launch site in Baikonur, Kazakhstan.

A dedicated training programme for all personnel who were involved in the construction and testing of the module, and the development of new cleanroom operating procedures were implemented.

All flight hardware, including the launcher upper stage and the launcher fairing, had to go through numerous cleaning cycles. Sterile 80% isopropyl alcohol was used for this. The cleanrooms are cleaned with more aggressive chemicals, including hydrogen peroxide solutions.

Most of the Schiaparelli hardware was exposed to dry heat treatment – exposing it to temperatures between 110°C to 125°C for several hours to several days – to reduce the microbiological contamination. Almost 3000 microbiological tests were carried out throughout the assembly, test and launch operations to check that these procedures were working well.

The planetary protection requirements are verified by internal and independent assessments throughout the project lifecycle during reviews, audits and tests. The final certificate of compliance is issued for the launch readiness review.

As a result of these special measures, the Agency has demonstrated that ExoMars 2016 is well within the constraints specified for the microbiological contamination and the probability of impact on Mars.

Mission partners

The ExoMars programme is a cooperation between ESA and the Russian Space Agency, Roscosmos.

Thales Alenia Space Italia is the overall industrial lead for the ExoMars programme as well as the industrial lead for the 2016 entry, descent, and landing demonstrator module, Schiaparelli. It also hosts the 2018 rover control centre at ALTEC in Turin, Italy.

Thales Alenia Space France is the industrial lead for the 2016 Trace Gas Orbiter.

Airbus Defence and Space United Kingdom leads the ExoMars 2018 rover developments and OHB Germany leads the ExoMars 2018 carrier development.

Italy, the United Kingdom, Germany, and France are supporting the provision of major instruments on both the 2016 Trace Gas Orbiter and the 2018 rover via their respective national space agencies, ASI, UKSA, DLR, and CNES.

Rosmoscos contributes two Proton launchers and launch services to the programme, as well as the descent module for the 2018 rover and the 2018 surface science platform. Russia also contributes scientific experiments to the 2016 Trace Gas Orbiter, the 2018 rover, and the 2018 surface science platform.

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DECA

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Team Leader: Detlef Koschny (detlef.koschny@esa.int)

Accreditation to press events

Members of the media wishing to attend ExoMars 2016 press events must register using the link provided in the related Call for Media published on the ESA Portal (www.esa.int).

For the launch event, the Call for Media was published in the week of 1 March with a deadline for receipt of applications of 11 March.

For the landing event, the Call for Media will be published two weeks before landing (to be confirmed) with a deadline for receipt of applications of three days before landing (to be confirmed).

Online transmission of press events

ESA press events covering the launch of ExoMars will be streamed live on:
www.esa.int
new.livestream.com/ESA/

ESA TV productions

ESA TV productions are made available via: television.esa.int

ExoMars online

Information about the mission and the role of the partners can be found on the following websites:

European Space Agency

Information for the general public: www.esa.int/exomars
In-depth information about ExoMars: exploration.esa.int
Websites for individual instruments can be found on the ExoMars outreach resources page: exploration.esa.int/exomars-outreach-resources/

ExoMars is also present on social media platforms:

@ESA_ExoMars, @ESA_TGO (active after successful launch), @ESA_EDM (active on approach to Mars). The official hashtag is #ExoMars

European Space Agency:
https://www.facebook.com/EuropeanSpaceAgency

ExoMars playlist:
https://www.youtube.com/playlist?list=PLbyvawxScNbvS4TUXFpaxXwUgz-ZUd7Pzx

ExoMars album: https://flic.kr/s/aHsk9hBDkb

ESA channel: https://www.instagram.com/europeanspaceagency/

Pictures, illustrations and animations

A variety of photographs, illustrations and animations are available for non-commercial use.

An extensive collection of illustrations can be found online, in particular:

All ExoMars images and videos: http://exploration.esa.int/multimedia-gallery/
Best of ExoMars images: http://exploration.esa.int/multimedia-gallery/best-of-exomars/
Trace Gas Orbiter: http://exploration.esa.int/multimedia-gallery/trace-gas-orbiter
Schiaparelli: http://exploration.esa.int/multimedia-gallery/schiaparelli/
Instruments: http://exploration.esa.int/multimedia-gallery/exomars-instruments/
People: http://exploration.esa.int/multimedia-gallery/exomars-people

ExoMars in ESA's multimedia gallery: http://www.esa.int/spaceinimages/content/search?SearchText=exomars&img=1&SearchButton=Go

ESA's Photo Library for Professionals: http://www.esa-photolibrary.com

ESA's Video Library for Professionals: http://www.esa.int/esatv/Videos_for_Professionals

Appendix A: Launch Event at ESOC, Darmstadt, 14 March 2016

Provisional schedule for the ExoMars launch event

08:00 CET Doors open

09:30 CET Morning programme, including live launch coverage

10:50 CET Break

12:00 CET Afternoon programme, including regular live updates on the status of the mission, a series of dedicated presentations on the scientific goals and operational challenges and milestones of the ExoMars missions, and informal question and answer sessions and interview opportunities for media/social media participants

19:00 CET Break

22:10 CET Evening programme, including expected confirmation of spacecraft separation, solar array deployment and first acquisition of signal

22:45 CET End of event

Speakers at the launch event

Jan Wörner
Director General, ESA

Rolf Densing
ESA Director of Operations
Head of ESOC establishment

Igor Komarov
Director General, Roscosmos

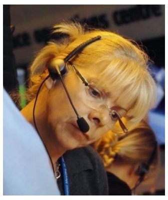
Pascale Ehrenfreund
Chairwoman of the Board, DLR

Mark McCaughrean
Senior Advisor to
ESA's Director of Science

Jorge Vago
ExoMars Project Scientist,
ESA

Daniil Rodionov
ExoMars Project Scientist,
IKI

Olivier Bayle
ExoMars EDM Lander
Engineer



Pia Mitschdoerfer
ExoMars TGO Orbiter
Systems Engineer

Gerhard Kminek
Planetary Protection Expert,
ESA

Michel Denis
ExoMars Flight Director

Micha Schmidt
ExoMars Deputy Flight
Director

Michael Khan
ExoMars Mission Analyst

Rolf de Groot
ESA Coordinator for Robotic
Exploration

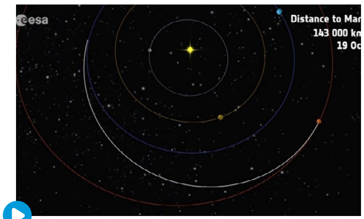
Carlo Bettanini
Project Manager, DREAMS
(CISAS, Università di
Padova, Italy)

Marco Trovatello
ESA Cross Media Coordinator

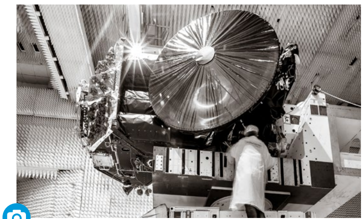
Appendix B: Selected images and videos

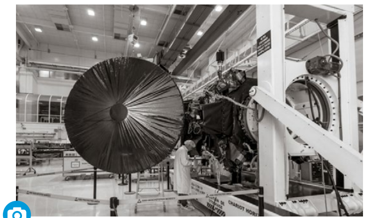
A full selection of images and videos is available at exploration.esa.int/multimedia-gallery/


ExoMars 2016: launch & journey to Mars
http://exploration.esa.int/mars/57422


ExoMars 2016: journey to Mars
http://exploration.esa.int/mars/57447


ExoMars 2016: arriving at Mars
http://exploration.esa.int/mars/57449

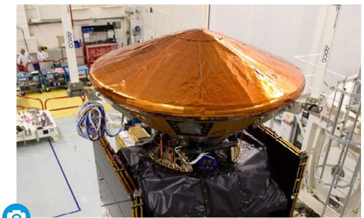

Trace Gas Orbiter in the compact antenna test range
http://exploration.esa.int/mars/57089


Trace Gas Orbiter with high gain antenna
http://exploration.esa.int/mars/57091

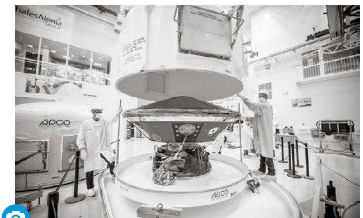

Deployment test of the Trace Gas Orbiter solar arrays
http://exploration.esa.int/mars/56917


ExoMars 2016 Trace Gas Orbiter
http://exploration.esa.int/mars/57100


Schiaparelli flight model
http://exploration.esa.int/mars/57104


Schiaparelli installed at the top of the Trace Gas Orbiter
http://exploration.esa.int/mars/56916


Schiaparelli in cleanroom
http://exploration.esa.int/mars/57106


Schiaparelli placed in transport container
http://exploration.esa.int/mars/57107


Trace Gas Orbiter in Baikonur
http://exploration.esa.int/mars/57113

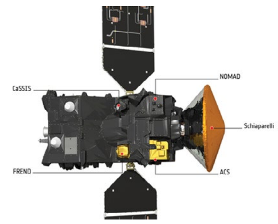

Trace Gas Orbiter and launch vehicle adapter in Baikonur
http://exploration.esa.int/mars/57132


Biosampling Schiaparelli
http://exploration.esa.int/mars/57141


Trace Gas Orbiter being moved in the cleanroom at Baikonur
http://exploration.esa.int/mars/57153


Fuelling Schiaparelli at Baikonur
http://exploration.esa.int/mars/57286


Fuelling the Trace Gas Orbiter at Baikonur
http://exploration.esa.int/mars/57452

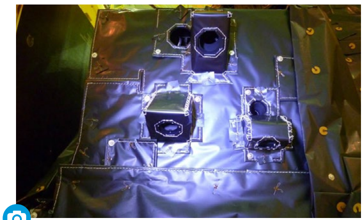


ExoMars 2016: Trace Gas Orbiter and Schiaparelli
http://exploration.esa.int/mars/56666

ExoMars 2016: Trace Gas Orbiter and Schiaparelli
http://exploration.esa.int/mars/56669

ExoMars 2016: Trace Gas Orbiter and Schiaparelli
http://exploration.esa.int/mars/56670

ExoMars 2016: Trace Gas Orbiter and Schiaparelli
http://exploration.esa.int/mars/56673



NOMAD flight model
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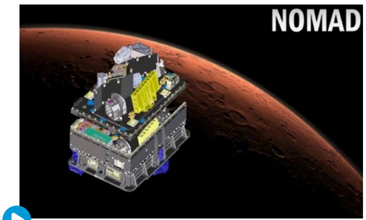
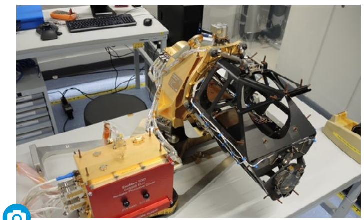


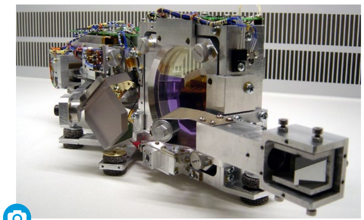
The NOMAD instrument
http://exploration.esa.int/mars/57475



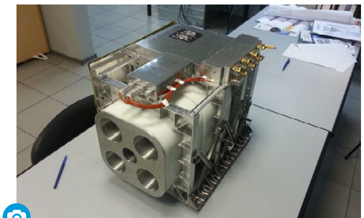
CaSSIS flight model
http://exploration.esa.int/mars/56791

The CaSSIS team from the University of Bern
http://exploration.esa.int/mars/56792

Atmospheric Chemistry Suite (ACS) flight model
http://exploration.esa.int/mars/57472

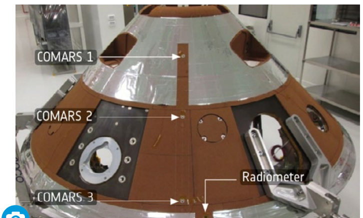


TIRVIM spectrometer on ACS
http://exploration.esa.int/mars/57473

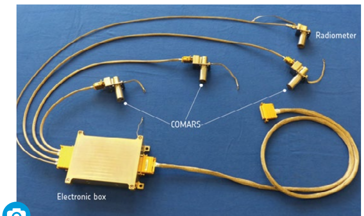


The FREND flight spare model
http://exploration.esa.int/mars/57485

Inspection of FREND flight model
http://exploration.esa.int/mars/57237



COMARS+ sensors on Schiaparelli
http://exploration.esa.int/mars/57377



COMARS+ flight hardware
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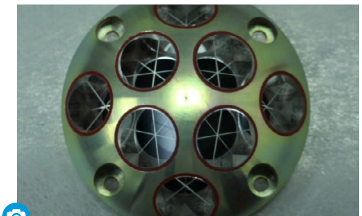
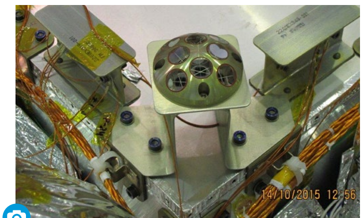
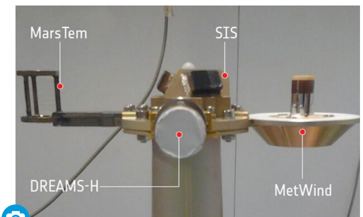


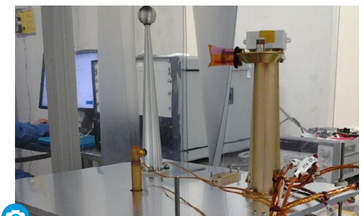
Retroreflector for ExoMars Schiaparelli
http://exploration.esa.int/mars/57466



INRRI integrated on board ExoMars Schiaparelli
http://exploration.esa.int/mars/57467



MetMast with sensors - annotated
http://exploration.esa.int/mars/56538



DREAMS flight model
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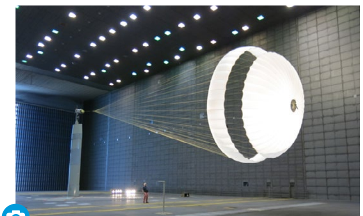
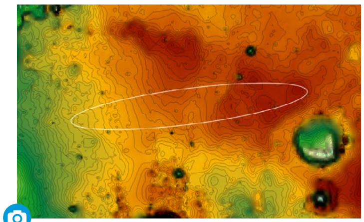
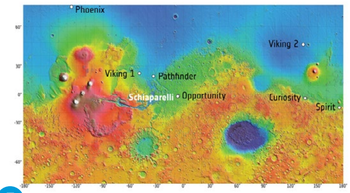


Schiaparelli's parachute during testing
http://exploration.esa.int/mars/57383


Schiaparelli's parachute with team
http://exploration.esa.int/mars/57384


ExoMars 2016 landing site
http://exploration.esa.int/mars/57446



Landing sites on Mars
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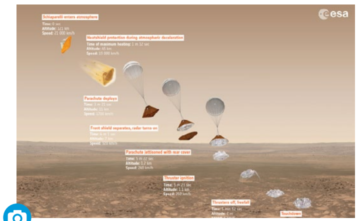

ExoMars 2016 Schiaparelli
descent sequence
http://exploration.esa.int/mars/57464

Appendix C: Mission Milestones - ExoMars 2016 Timeline

14-25 March 2016	Launch window
Early April	Testing NASA radio transponder
Up until 6 weeks after launch	- Commissioning of Trace Gas Orbiter instruments - Commissioning of Schiaparelli instruments
Up until end June	Cruise phase
Mid July – mid August 2016	Deep space trajectory manoeuvres
28 July	Largest engine burn
September – October 2016	Navigation measurements (delta-DOR)
9 October 2016	Start of 24/7 ground station contact with TGO
16 October 2016	Schiaparelli – TGO separation*
17 October 2016	TGO performs Mars avoidance manoeuvre
19 October 2016	TGO insertion into Mars orbit
19 October 2016	Schiaparelli lands on Mars*
19 October 2016	Schiaparelli science operations begin
December 2016	Apocentre reduction manoeuvres (from the initial 4-sol orbit to a 1-sol orbit)
17 January 2017	TGO changes inclination to science orbit (74°)
January 2017 – November 2017	Aerobraking phase (TGO lowers its altitude to 400 km circular orbit)
December 2017	TGO starts data relay operations to support NASA landers on Mars
December 2017 – December 2019	TGO science operations
11 July - 11 August 2017	Superior solar conjunction (critical operations are paused while the Sun is between Earth and Mars)
15 January 2019	Start of the TGO data relay operations to support communications for the rover mission and for the surface science platform
December 2022	End of TGO mission

*For details of the timeline for the entry, descent and landing of Schiaparelli, see Appendix D.

Appendix D: Landing on Mars; summary of key events on 19 October

This information is also available is available is available as an infographic: exploration.esa.int/mars/edl-sequence

	Time since entry into atmosphere (min:s)	Altitude above surface (km)	Velocity (km/h)
 Schiaparelli enters atmosphere	0	121	21 000
 Heat shield protection during atmospheric deceleration - (time of maximum heating)	1:12	45	19 000
 Parachute opens	3:21	11	1700
 Front shield separates, radar turns on	4:01	7	320
 Parachute and rear cover jettisoned	5:22	1.2	240
 Propulsion system ignition	5:23	1.1	250
Backshell avoidance manoeuvre	5:26	0.9	252
 Propulsion system off; free-fall	5:41	0.002	4
 Touchdown	5:42	0	10

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