ESA EXOMARS 2016 MISSION

Congresso della SAIT
Museo della Scienza e della Tecnologia di Milano
15 Maggio 2014

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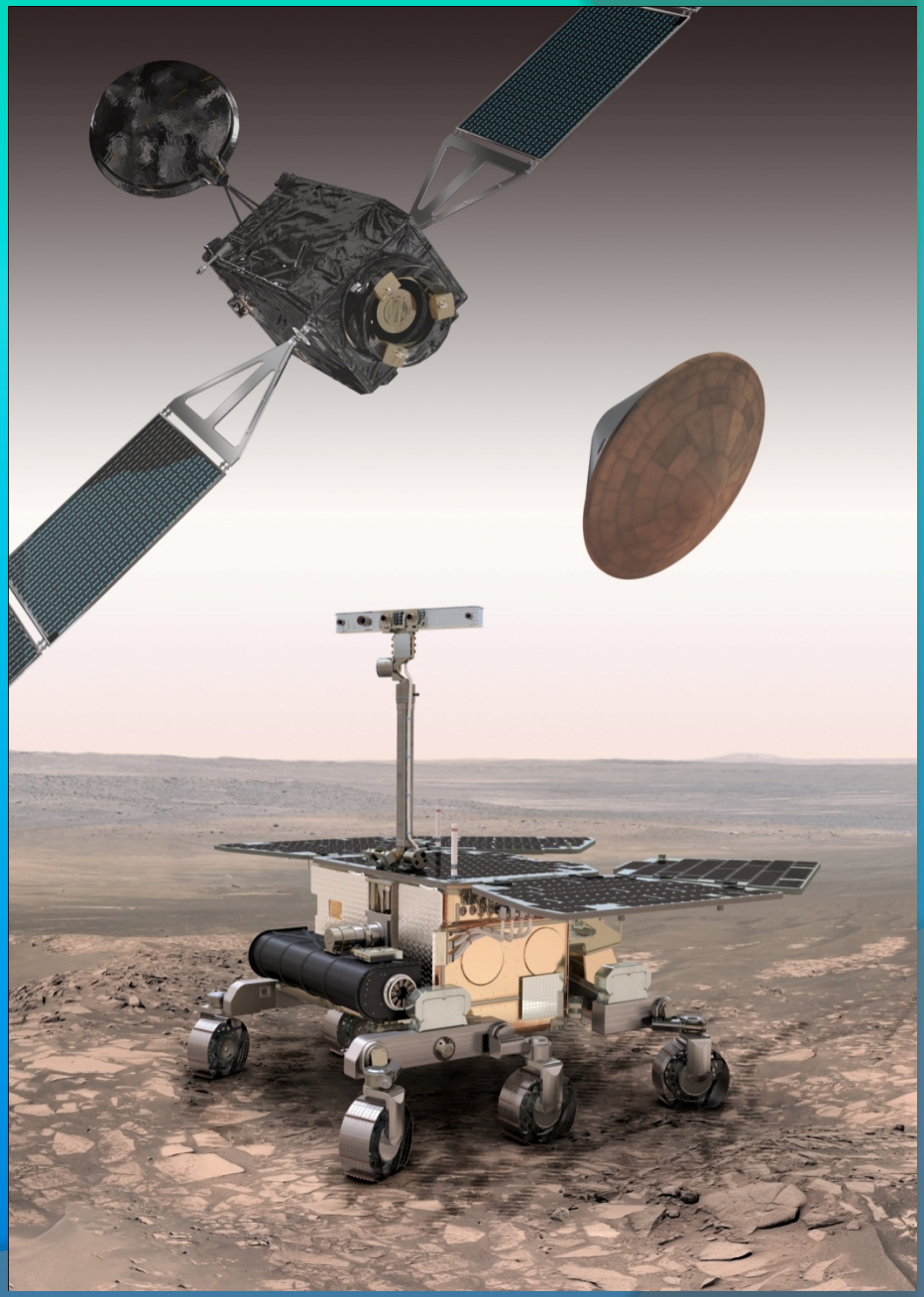
ExoMars Mission

- The ExoMars Program is carried out by ESA in cooperation with Roscosmos
- 2 missions are foreseen:
  - 2016 – TGO Orbiter + EDM
  - 2018 – rover + surface platform
- ExoMars program will be a step forward both for technological achievements and scientific goals.

ExoMars Mission

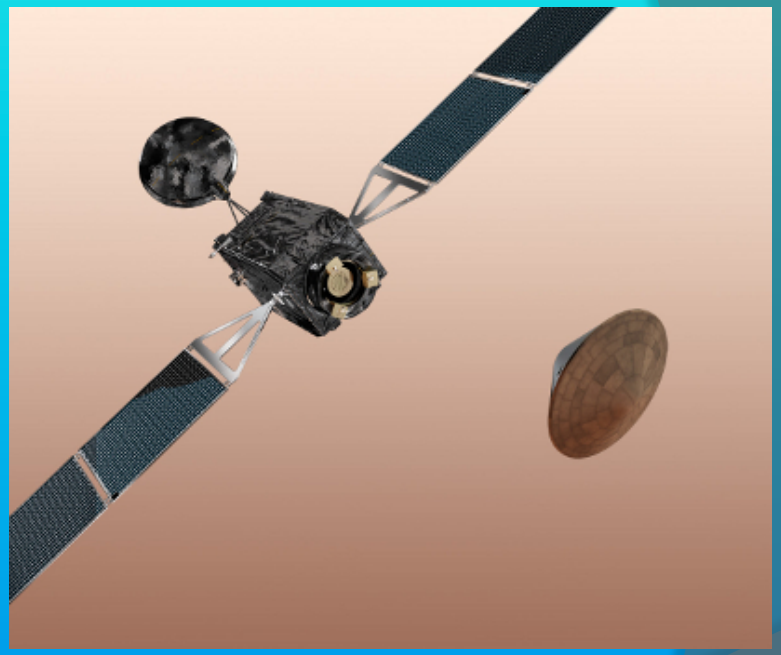
- Technological achievements:
  - EDL of a payload on the surface of Mars;
  - Surface mobility with a rover;
  - Access to the subsurface to acquire samples;
  - Sample acquisition, preparation, distribution and analysis

- Scientific achievements:
  - Search for signs of past and present life on Mars (rover);
  - Investigate how the water and geochemical environment varies (rover);
  - Investigate Martian atmospheric trace gases and their sources (orbiter);
  - Measuring key meteorological parameters during the statistical dust storm season (EDM)
  - Study the electrical properties of the martian atmosphere (EDM)

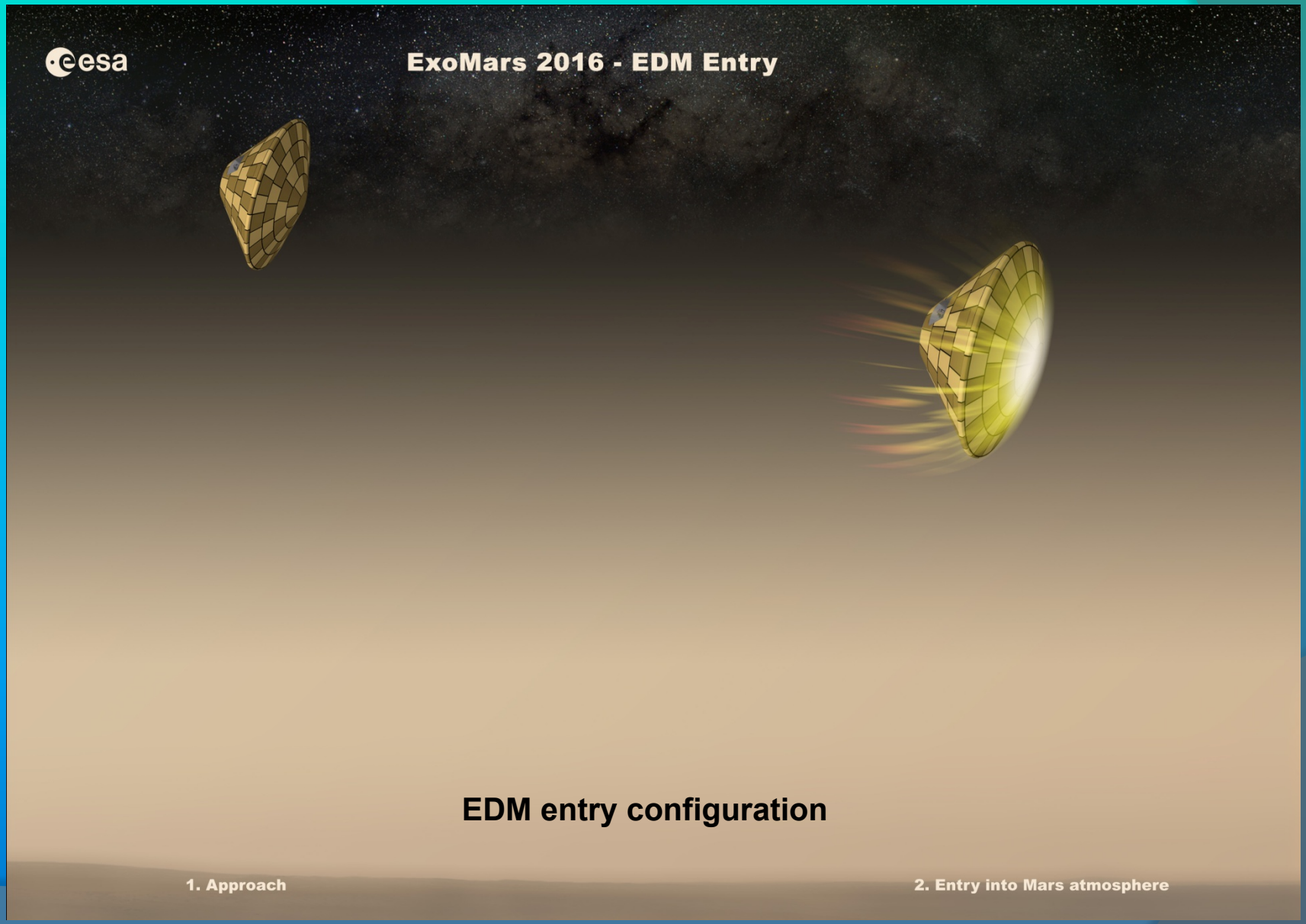


ExoMars 2016 Mission

- The EXM Spacecraft Composite will be launched in early January 2016 and will arrive at Mars on October of 2016.
- Prior to arrival at Mars, the EDM will be released from the Orbiter Module and will enter the Mars atmosphere from a hyperbolic arrival trajectory.
- Total entry mass of the EDM: 600 kg
- TGO will be put into a circular orbit @ ~ 400 km altitude
- EDM will land during the Mars Global Dust Storm Season (around L_S = 244°)
- EDM is designed to survive on the surface of Mars for a nominal science operations period of 2 sols up to 4 sols
- The EDM will provide Europe with the technology for landing on the surface of Mars with a controlled landing orientation and touchdown velocity

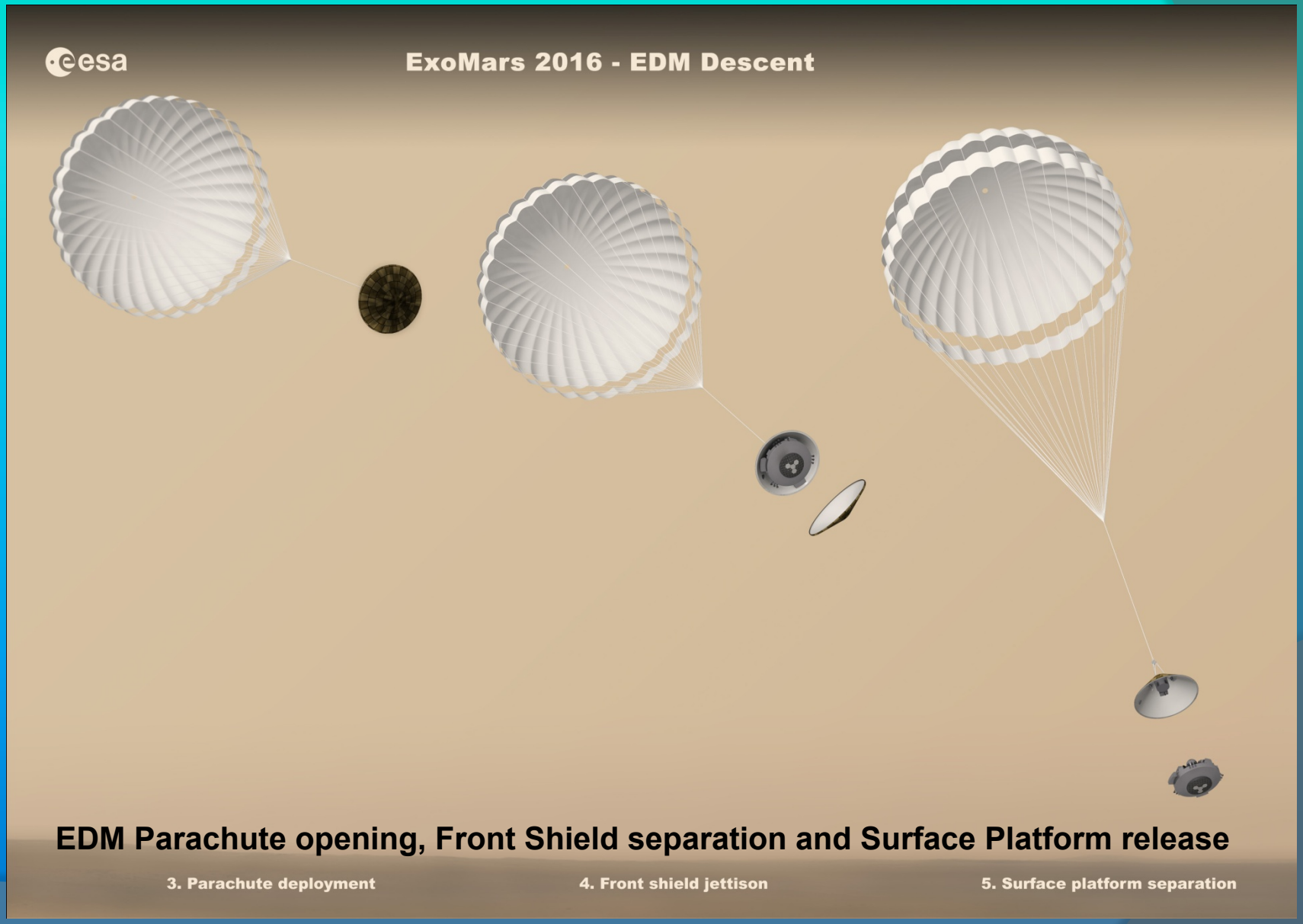


Entry on Mars

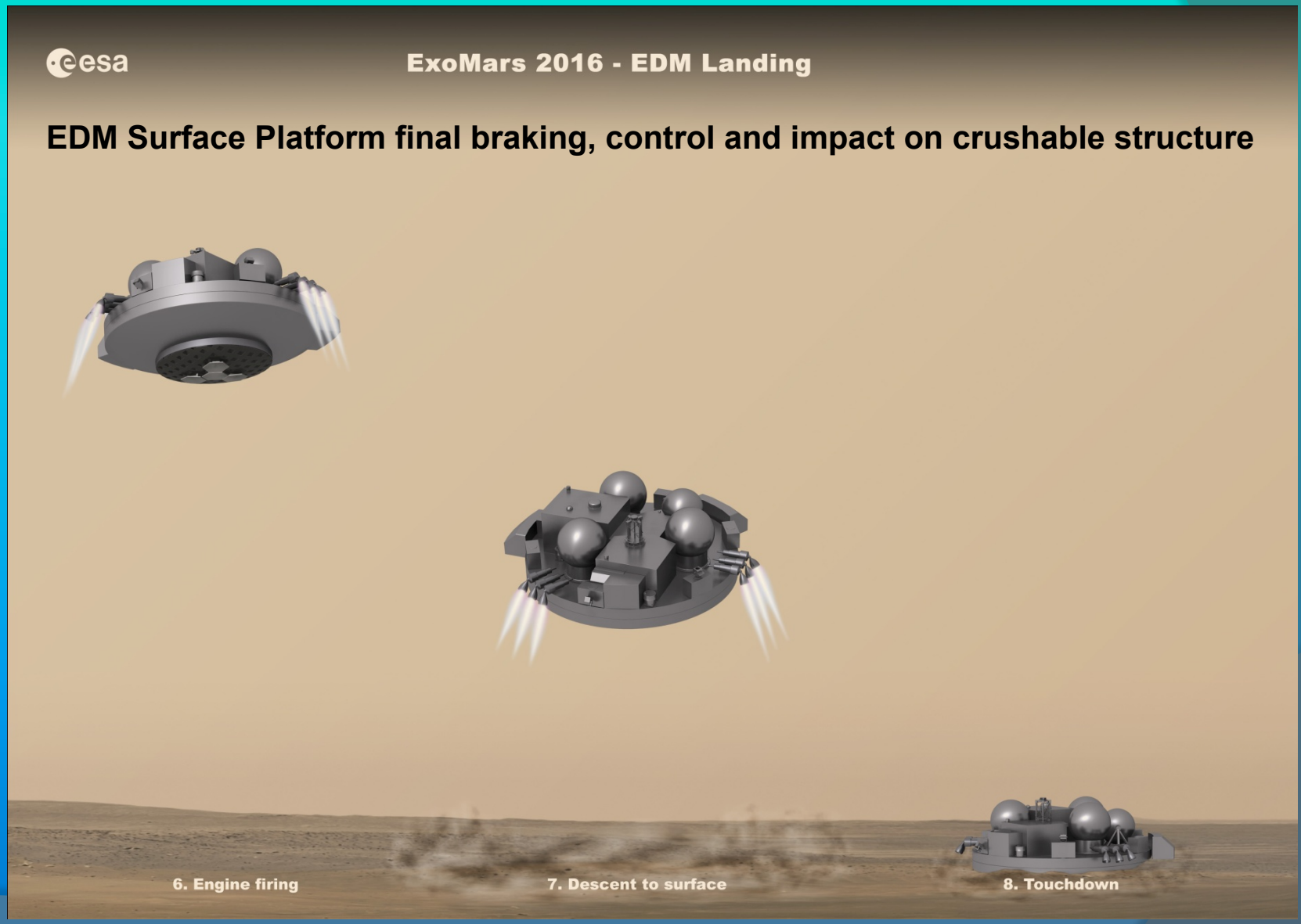


EDM entry configuration

Entry on Mars

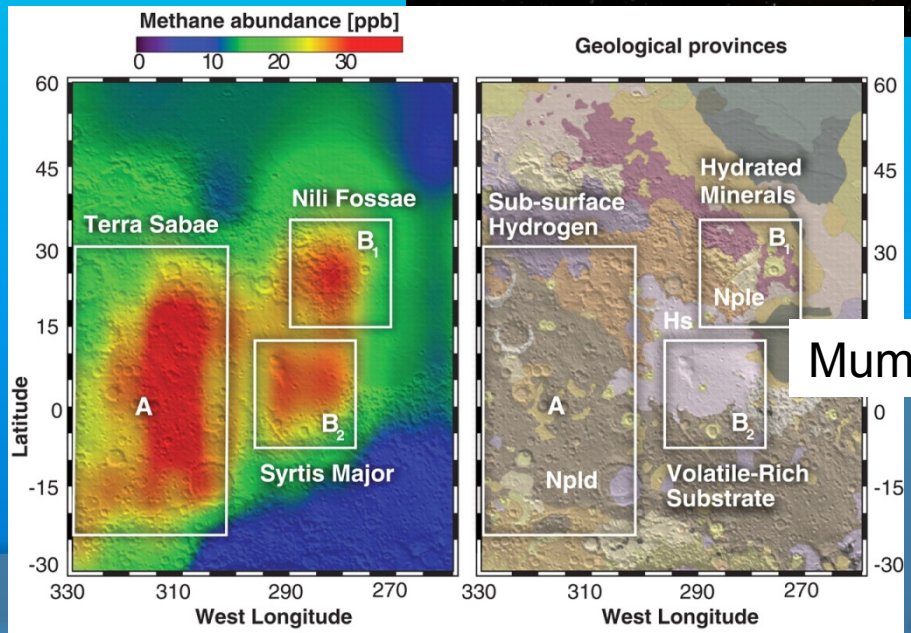


Entry on Mars



Trace Gas Orbiter (TGO)

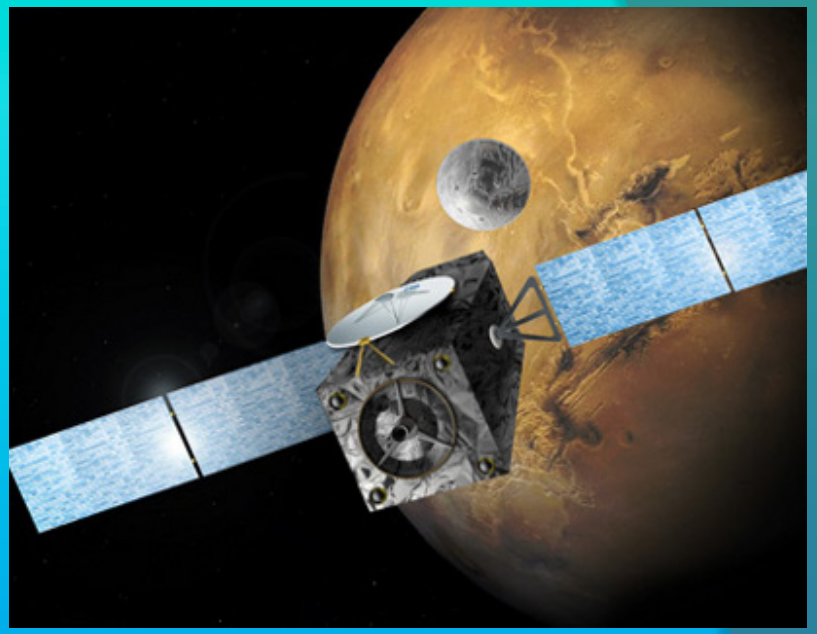
- Main goal of TGO is to gain a better understanding of methane and other atmospheric trace gases (< 1%), that could be evidence for possible biological or geological activity.
- Starting from 2003, space and Earth – based observations have shown the presence of methane in the Martian atmosphere.
- It has been shown to vary with seasons (high during the northern summer and low in winter) and to be concentrated in restricted areas.



Mumma et al., 2009

Trace Gas Orbiter (TGO)

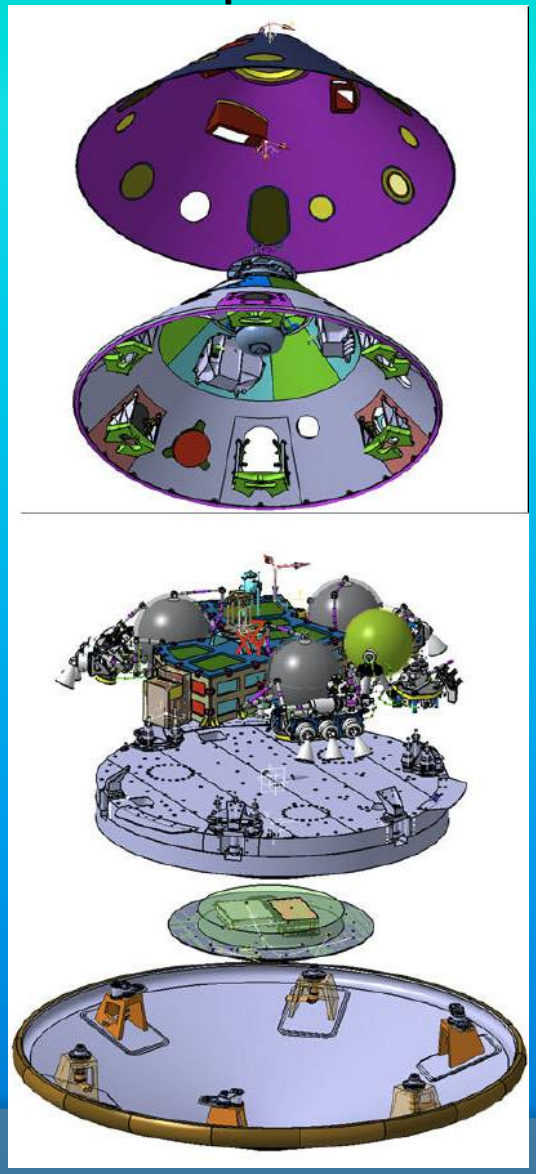
- Since methane is short-lived on geological time scales (some hundreds of years), its presence is related to an active current source.
- Possible sources are:
  - Biological origin (extinct or extant)
  - Geologic origin (oxidation of iron – as in terrestrial hot springs, serpentinisation – that needs interaction of olivines with liquid water: hydrothermal activity)



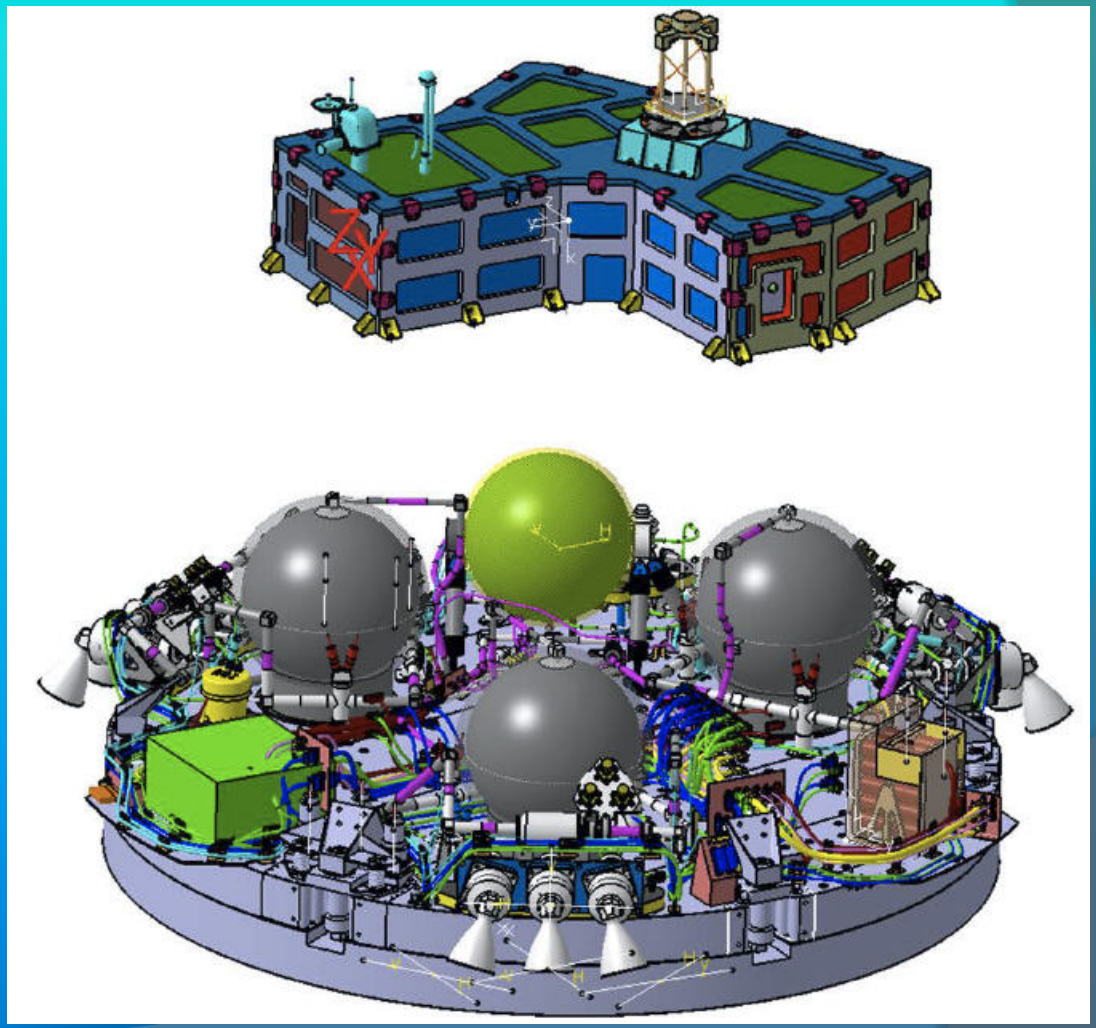
- TGO will carry a scientific payload (2 spectrometers: NOMAD and ACS, the CASSIS camera and a neutron detector: FREND) capable of detecting and characterizing trace gases in the Martian atmosphere, with an improved accuracy of 3 orders of mag. Compared with previous measurements.
- These measurements will provide evidences about the location and sources of these gases.
- These locations could be targeted as landing sites of future missions.

Entry and descent Demonstration Module (EDM)

EDM exploded view



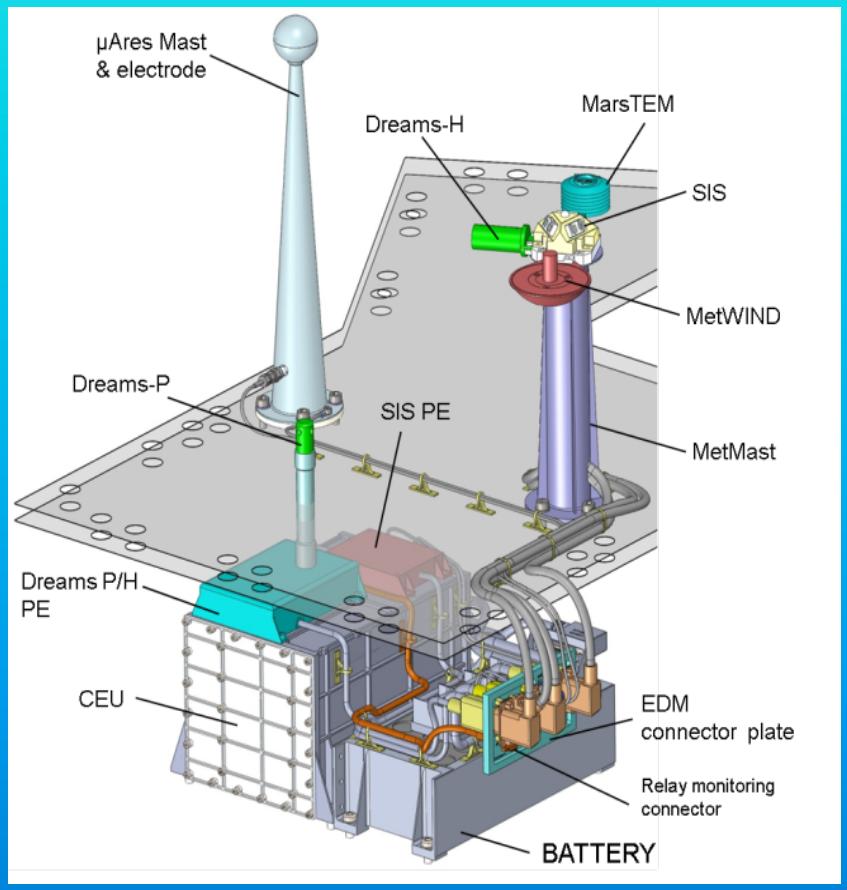
Central Bay (top) and Main Panel



EDM Scientific Payload

DREAMS

DUST CHARACTERIZATION, RISK ASSESSMENT AND ENVIRONMENT ANALYSER ON THE MARTIAN SURFACE



DREAMS is a small meteorological station with the additional capability to measure the electrical field at the Martian surface

DREAMS is an integrated and autonomous system.

It has been selected on June 2011 by ESA/NASA to be accommodated on the ExoMars 2016 EDM mission for surface investigations.

DREAMS International Team includes researchers from 9 European Countries and from USA.

Science Overview – Scientific goals

The ExoMars 2016 EDM offers a unique chance to make scientific measurements during Mars' statistical dust storm season.

- Meteorological measurements
- Hazard
- First ever investigation of atmospheric electric phenomena at Mars

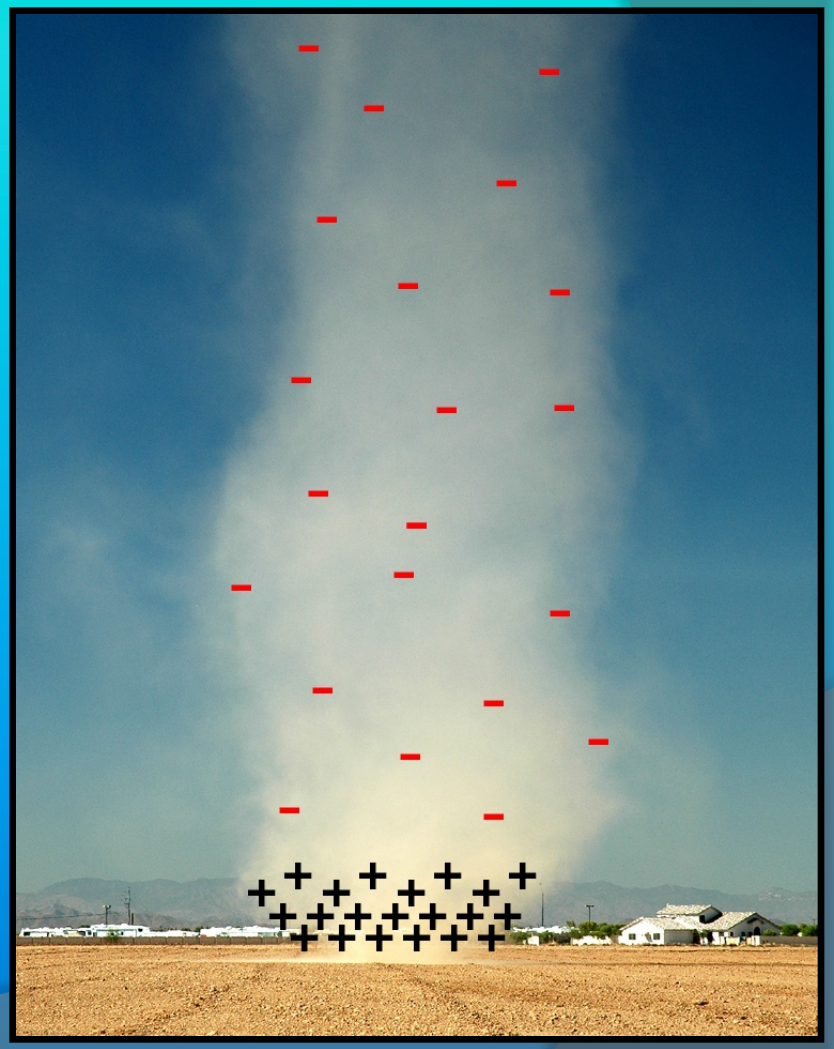
Science Overview – Scientific goals

- First ever investigation of atmospheric electric phenomena at Mars

- A global atmospheric electrical circuit is likely to exist on Mars.

- Atmospheric electrical phenomena are an important issue in many processes at the surface of Mars: dust transport, surface and atmospheric chemistry as well as habitability of the planet through their role in the production of oxidized constituents. Electrification processes may also affect a landed vehicle.

- Atmospheric ionization should be similar to that of the Earth's stratosphere but impact charging through collisions between windblown dust and the surface, or between dust particles themselves, is expected to be the dominant charging mechanism.



Science Overview – Scientific goals

- First ever investigation of atmospheric electric phenomena at Mars

• During Summer 2013, we carried on a field test campaign in the Moroccan desert, finalized to the study of the response of meteorological and electric field sensors during the period of frequent dust storms in the area.

• The Moroccan desert has been chosen for its similarity to the Martian surface.

• The deployed instrumentation includes meteorological, dust and electric field sensors

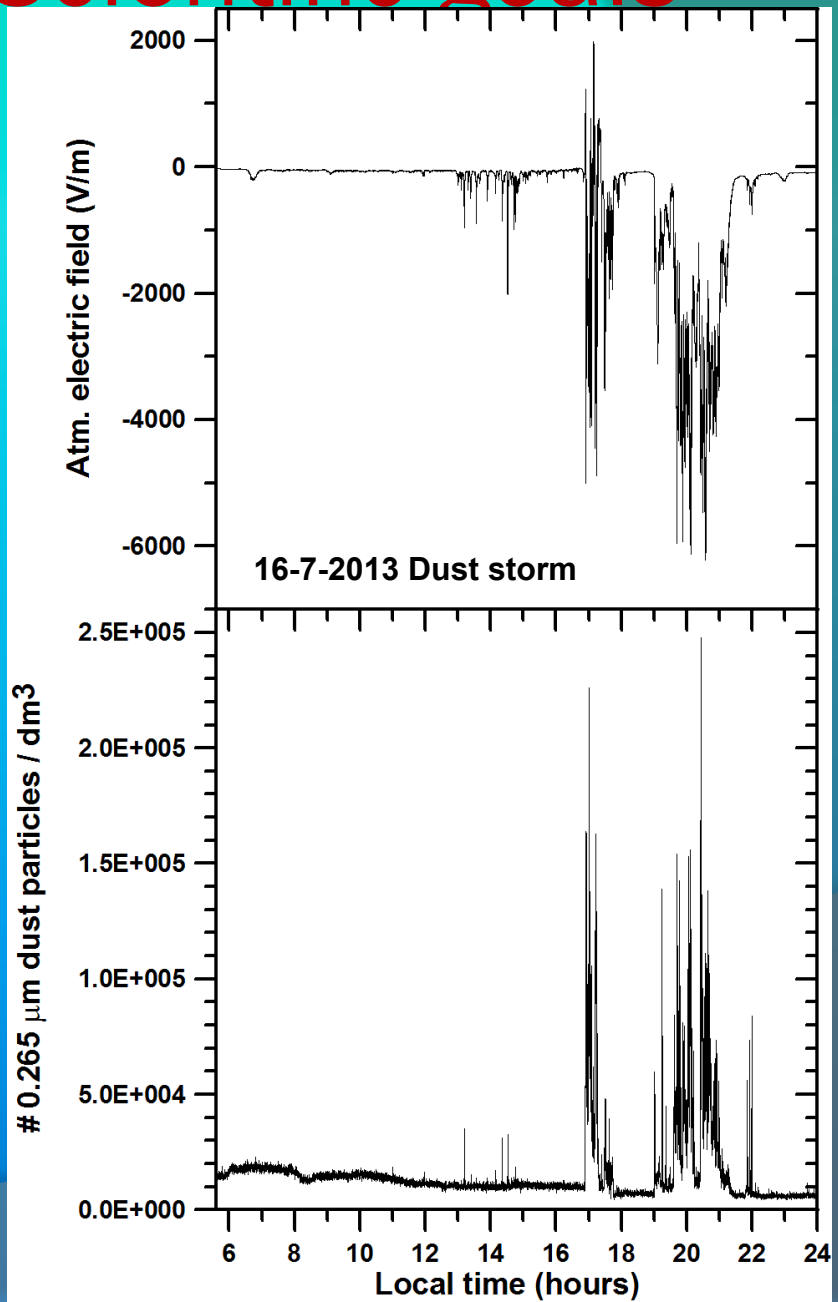
Science Overview – Scientific goals

- First ever investigation of atmospheric electric phenomena at Mars

Preliminary analysis of data acquired shows a large enhancement of the atmospheric electric field during dust storm events.

We also observed a strict correlation with the increase of lifting of fresh dust.

Esposito et al., *in preparation*



Science Overview – Scientific goals

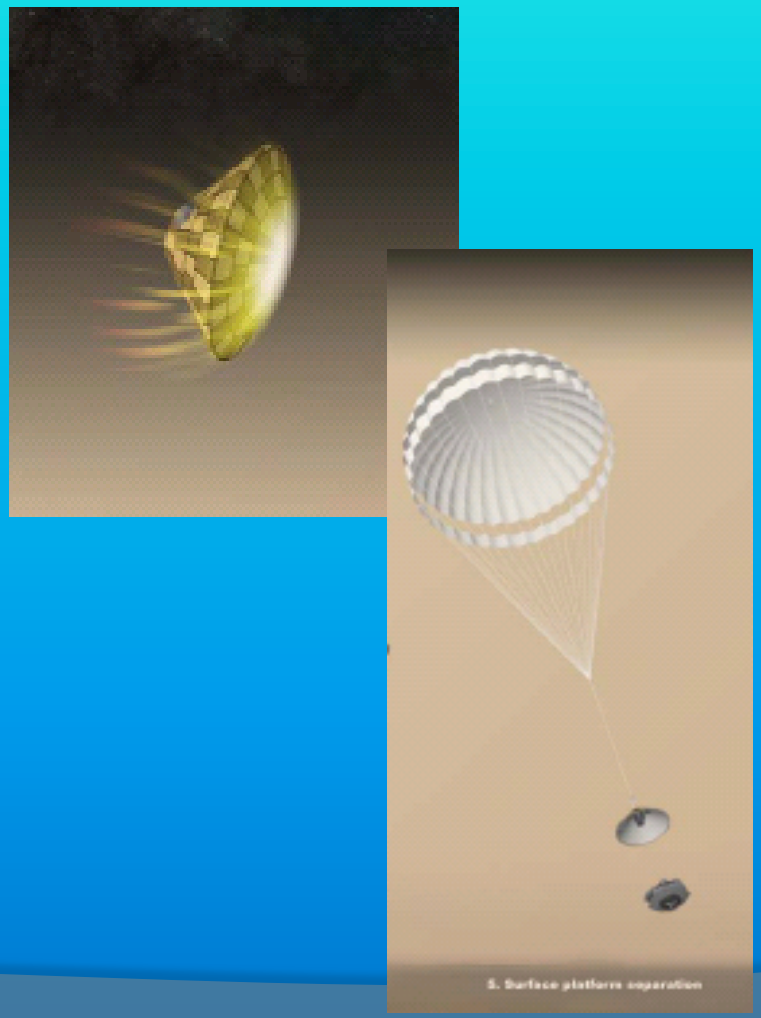
- First ever investigation of atmospheric electric phenomena at Mars

Intense electric fields, possibly capable of producing electrical breakdown, are expected at the time of dust storms and in the vicinity of dust devils.

High voltages can be generated in dust devil vortex, but limited by **electrical breakdown** (~25 kV/m for CO_2).

AMELIA Investigation

The main objective of the AMELIA experiment is to exploit the Entry Descent and Landing System (EDLS) engineering measurements for scientific investigations of Mars' atmosphere and surface.



AMELIA key science objectives:

- Investigation of the Martian atmosphere and meteorology by the analysis of the observed atmospheric profiles and by Mars atmosphere modelling.
- Investigation of the Martian dust environment and its influence on the Mars' climate and the possible hazardous to machine and humans in view of future Mars exploration.
- Engineering assessment of the Entry, Descent and Landing on Mars by trajectory and attitude reconstruction of the EDM and landing site characterization.

Conclusions

- ExoMars 2016 mission is composed by an orbiter (TGO) and a surface platform (EDM *Schiaparelli*)
- TGO will remotely observe the atmosphere of Mars searching for evidence of gases of possible biological importance (methane, etc.)
- EDM will provide Europe with the technology for landing on the surface of Mars with a controlled landing orientation and touchdown velocity.
- The 2016 mission has a very large Italian contribution.
- EDM is designed and built by Thales Alenia Space Italy (ExoMars Prime Contractor). It includes 2 Italian led experiments: DREAMS and AMELIA.
- EDM, even with low resources, will be able to perform novel measurements on Mars and help for the understanding of Martian environment and dust cycle.

ExoMars 2016 – Mission Phases

ExoMars 2016 Mission Phases Overview	
Launch Period	7-27 January 2016
EDM – Orbiter separation	16 October 2016
Orbiter insertion into Mars orbit	19 October 2016
EDM enters Martian atmosphere and lands on the target site	19 October 2016
EDM science operations	19 October - 23 October 2016 (to be confirmed)
Orbiter changes inclination to science orbit (74°)	25 October 2016
Apocentre reduction manoeuvres (from the initial 4-sol orbit to a 1-sol orbit)	27 October 2016
Aerobraking phase (Orbiter lowers its altitude)	4 November 2016 - mid 2017
Start operating the Orbiter scientific instruments	mid 2017
Superior conjunction (This is when the Sun is between Earth and Mars; Critical operations are paused.)	11 July - 11 August 2017
Start of the data relay operations to support communications for the rover mission	17 January 2019
End of mission	December 2022