DRILL SYSTEM

AURORA ExoMars is the first mission of the ESA planetary exploration programme. Thales Alenia Space Italia is the Prime Contractor for the entire project. In its operational scenario on Mars the ExoMars mission foresees the acquisition and on board analysis of soil samples taken to a depth of up to 2 metres and the investigation of the drilled borehole using spectrometric techniques in both visible and infrared ranges.

The key elements to perform this mission are: a drill unit capable of reaching the subsurface depth and recovering samples of material to the surface and an advanced compact spectrometer (Ma_Miss), which is directly integrated in the front section of the drill string. The complete drill unit is mounted on to the Exomars Rover via a two-degrees-of-freedom positioning device, an integral part of the Drill System.

The collected samples, once recovered to the surface, are discharged in a dedicated container and then transported inside the Rover Analytical Laboratory for final processing and distribution to the scientific instruments.

To cope with the very challenging two metres drilling depth requirement the Drill System has been based on multistroke technology, using one main drill tool and three extension rods. The drill penetrates the soil by a rotary/translation action.

The optical spectrometer Ma_Miss, devised by Prof Angioletta Coradini and developed in the frame of an Italian Space Agency contract, is implemented within the drill unit and, by using an appropriate optical front end located in the drill tool, it provides observation laterally of the walls of the progressively excavated hole.

KEY FEATURES

The key features of the Exomars Drill System include:

- Drilling depth 2m
- Sample size diameter 10mm, length 30mm
- Power needed 80W
- Mass 21kg (inclusive of control electronics).

EXOMARS

The Drill System has been tested and verified in a wide variety of conditions including:

- Drilling and sampling in the 0.5m range in laboratory and Mars-like pressure and temperature conditions
- Sample discharge into the Sample Processing and Distribution System (SPDS) receiving port
- Complete drilling and sampling down to 2m in laboratory conditions via dedicated test equipment
- Complete drilling and sampling down to 2m with drill integrated on the Rover
- Testing of Ma_Miss prototypes.

The Drill System integrated on to the Exomars Rover breadboard during the relevant test campaign.

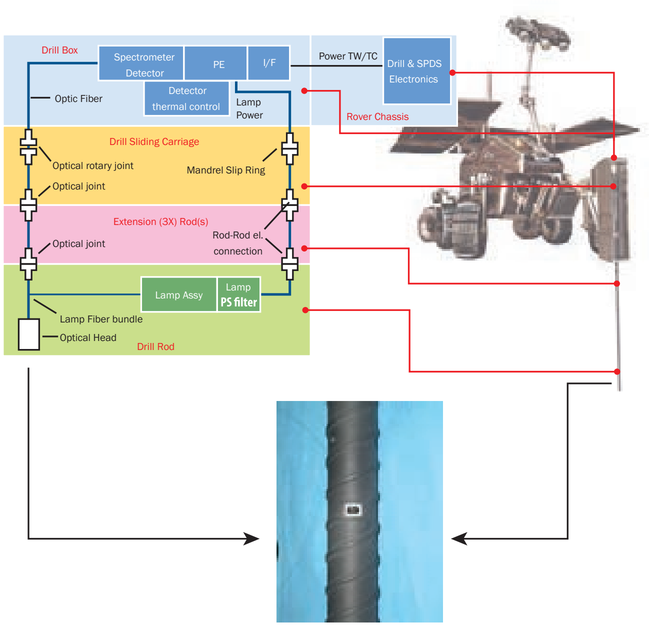
Many samples have been collected in the different conditions and some examples are provided below.

Example of collected samples: sandstone, claystone and hydrothermal deposits (geyserite) and gypsum.

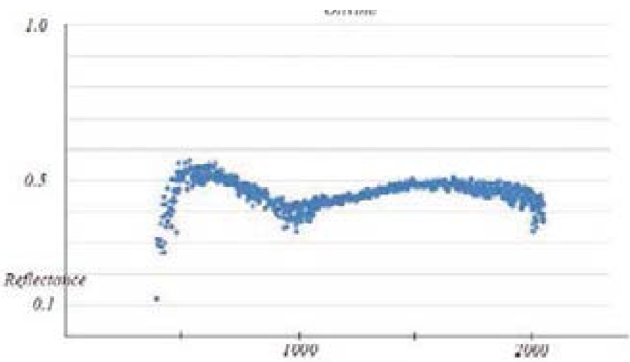
An overall range of the resources needed to drill and core (e.g. vertical thrust, torque, power, etc) is summarised in the following table and are clearly dependent on the type of material being encountered.

PARAMETER	RANGE	REMARK
Vertical Thrust	10N to 450N	Upper value for very hard and tough soils
Advancing Speed	0.3mm/min to >20mm/min	Lowest values for marble like material
Torque	1Nm to 6Nm	Upper value for hard material and widely used bit
Power	70W to 80W	In the worst conditions

Ma_Miss prototypes have been successfully tested for design validation of the optical system to be integrated within the drill tool. An example of overall connection schematics and of an acquired optical signal obtained by observing a sample of volcanic rock is shown.



Ma_Miss connection schematics and optical observation port.



Ma_Miss example of optical signal obtained in Olivine.