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Italian Contribution to NASA/ESA Mars Sample Return Campaign

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Abstract. Mars Exploration is one of the key topics in the national space exploration plan. The consolidation scientific expertise and system engineering capability over last decades allowed play an important role in past-running Mars missions such as Mars Express, MRO and ExoMars planned for 2022. Next step is the NASA/ESA Mars Sample Return campaign to return back to Earth samples from the Red Planet. The joint MSR campaign deals with challenging technology development and complex international collaboration.

Key words. Mars Exploration – Sample Return

1. Introduction

The joint MSR plan started with the launch of NASA Mars2020 rover, and is expected to land in Jezero Crater area on February 2021. The, rover Perseverance will start to investigate the landing site and to collect samples. The collected samples will be stored safely into the sample tubes and dropped on Mars surface for subsequent caching by the Sample Fetch Rover. Mars samples are expected back to Earth by 2031. The MSR campaign stimulate large interest among the Italian community involved in planetary science and astrobiology: the availability of Mars samples on Earth open new frontiers for science investigation aimed to search for bio-signature (Grady M. M. 2020; Haltigin et al. 2018; Ewards et al. 2019; iMOST Group 2019; MSPGl. 2019). Italian Space Agency confirm the full support for technology development and for the scientific community involved.

2. Italian contribution to Mars Sample Return Campaign

As ESA Member State, Italy is involved in the European contribution to NASA/ESA MSR campaign in both Earth Return Orbiter (ERO) and in surface elements of the mission.

2.1. Sample Fetch Rover's (SFR) robotic arm and Sample Transfer Arm (STA)

The Sample Fetch Rover is equipped with a robotic arm (SFA) designed to grab the samples tubes collected by NASA Mars 2020 Perseverance rover. The arm is extendable up to about 110 cm, its control system features 6 degrees of freedom and is equipped with a gripper or end effector at its tip. The design of the SFR robotic arm, is now entering into an advanced phase with the development of the first robotic arm prototype (breadboard) to show the high capabilities of the system.

NASA lander's STA is a more complex arm, with 7 degrees of freedom that exceeds 200 cm of extension (currently in breadboard phase).

2.2. Earth Return Orbiter (ERO)

The spacecraft is composed by the Return Module and the Orbit Insertion Module:

- Return Module (RM) - hosts the NASA payload devoted to the capture of the Martian samples orbiting around Mars, of their containment and delivery to Earth.
- Orbit Insertion Module (OIM) - is an additional chemical propulsive stage, for inserting the spacecraft into Mars orbit. This module is crucial as he will allow to reduce the spacecraft velocity enabling the Martian gravity to capture ERO in a stable orbit. After the maneuver successfully completed, IOM will be separated from RM in order to save mass prior to the return to Earth
- The Italian Contribution to ESA's Earth Return Orbiter regards mainly:
- Communication System, consisting of the elements allowing the data transmission between Earth and ERO and Mars
- Orbit Insertion Module (OIM)and related thermo-mechanical, propulsion and electrical architectures
- Assembly Integration and Test(AIT) phase for the Proto-Flight model of the ERO Spacecraft composing elements in its test facilities of Turin and Toulouse.

2.3. Rover Operations Control Center (ROCC)

Developed for ExoMars rover, it represents a facility for Planetary Surface Operation. Rover activity planning, command sequencing and commands validation can be done every sol by telemetry downlink to Earth and the next uplink opportunity of telecommand (TCs) to the Rover

3. Conclusions and open questions

In addition to contribution to MSR elements under ESA side, Italian Space Agency (ASI) pays particular attention to initiatives aimed to prepare the next generation of scientist which will play an important role in planetary science and astrobiology once the Mars Samples will be available on Earth. ASI intents to guarantee the necessary resource to allow national community be part of the international MSR science team and to answer to questions such as:

- Define what we have to look for when analysing the samples
- Improve models, instruments and lab equipment toward new scientific objectives
- Establish samples handling and preparation procedures

References

Grady, M.M., 2020, Space Sci Rev 216, 51.

Haltigin, T., Lange, C., Mugnuolo, R., Smith, C. & iMars2 Working Group, 2018, Astrobiology, Vol: 18 Issue, S1-S131

Ewards, C. D.,Muirhead, B. K., Beaty, et al., 2019, Proposed Joint NASA-ESA Architecture for the Retrun of Martian Samples, Ninth International Conference on Mars, LPI Contrib. No. 2089

International MSR Objectives and Samples Team (iMOST), 2019, The potential science and engineering value of samples delivered to Earth by Mars sample return; Meteoritics & Planetary Science 54, Nr 3, 667–671

MSPG (MSR Science Planning Group: co-chairs M. Meyer and E. Sefton-Nash, 2019, A Framework for Mars Returned Sample Science Management. Unpublished white paper, https://mepag.jpl.nasa.gov/reports.cfm?expand=mspg