

**MARCO POLO – A MISSION TO RETURN A SAMPLE FROM A NEAR-EARTH OBJECT.** D. Koschny (3), Antonella Barucci (1), Makoto Yoshikawa (2), Hermann Böhnhardt (4), John Brucato (5), Marcello Coradini (6), Elisabetta Dotto (7), Ian Franchi (8), S. Green (8), Jean-Luc Josset (9), Junichiro Kawaguchi (3), Patrick Michel (10), Karri Muinonen (11), Jürgen Oberst (12), Hajime Yano (2), Richard Binzel (13), David Agnolon (3), Jens Romstedt (3); 1 – LESIA, Paris Observatory, F, 2 – JSPEC/ JAXA, J, 3 – Detlef.Koschny@esa.int, ESTEC/ESA, Keplerlaan 1, Postbus 299, NL-2200 AG Noordwijk, NL, 4 – MPS Lindau, D, 5 – INAF-OAA, Florence, I, 6 – ESA HQ, Paris, F, 7 – INAF-OAR, Rome, I, 8 – The Open University, UK, 9 – Space Exploration Institute, Neuchatel, CH, 10 – Univ. Nice Sophia-Antipolis, Obs. de la Côte d’Azur, F, 11 – Univ. Helsinki Observatory, FIN, 12 – DLR Berlin, D., 13 – MIT, U.S.A.

**Introduction:** As part of the European Space Agency’s (ESA) Cosmic Vision program, which defines new missions for implementation in the time range 2015 – 2025, ESA currently studies a mission concept called Marco Polo, in collaboration with the Japanese space agency JAXA. It will be launched in 2017 and fly to a Near-Earth Object (NEO), perform characterization of the object, collect up to three samples from the surface and return them to Earth so that they can be studied in ground-based laboratories. This paper will present the science goals and the current study status.

**Scientific goals:** NEOs are part of the small body population in the solar system, which are leftover building blocks of the solar system formation process. They offer important clues to the chemical mixture from which planets formed about 4.6 billion years ago. Studying samples from a NEO will be an excellent opportunity to study the formation and the evolution of the Solar System, and their potential contribution to the formation of life.

The detailed scientific objectives are:

1. What were the initial conditions and evolution history of the solar nebula?
2. Which were the properties of the building blocks of the terrestrial planets?
3. How did major events (e.g. agglomeration, heating) influence the history of planetesimals?
4. Do primitive class objects contain presolar material yet unknown in meteoritic samples?
5. What are the organics in primitive materials?
6. How can organics in NEOs shed light on the origin of molecules necessary for life?
7. What is the role of impacts by NEOs in the origin and evolution of life on Earth?

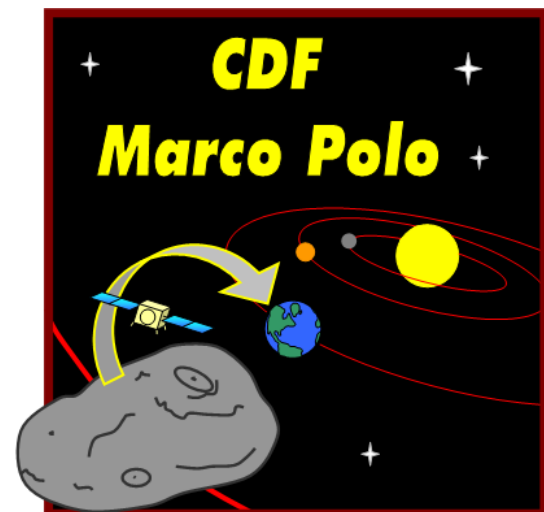
**Proposed mission:** The proposed mission assumes a mother spacecraft built by JAXA, with a shared (JAXA/ESA) payload and two sampling devices, one from each Agency. Also, the Earth Reentry Vehicle (ERV) would be a shared development. Depending on the available mass, a European Lander could augment the scientific return of the mission.

**Current status of the ESA mission study:** In parallel to JAXA considering how to perform the mission, ESA is currently in the process of studying

Marco Polo in their internal Concurrent Design Facility (CDF). The current baseline mission for the ESA study is to go to B-type asteroid 1989UQ. The current baseline launch window is from 10-30 Sep 2017, using a Soyuz 2-1b Fregat launcher from the Kourou launch center in French Guyana. A single block spacecraft (no separate propulsion module) will be launched. After one Earth flyby and a Venus flyby, the spacecraft will arrive at the asteroid in Dec 2020. It will stay there for 2.5 years. After a global characterization of the NEO, it will perform closer investigations of up to 5 potential sampling sites. The three best sites will be selected to retrieve a sample from the asteroid. This will be achieved by the spacecraft slowly approaching the surface of the NEO until the sampling mechanism can grab the sample. Up to three samples can be retrieved.

A transfer mechanism will transfer the samples into the Earth Return Capsule (ERC). After the 2.5 years, the spacecraft will return to Earth and eject the ERC into Earth’s atmosphere. The ERC can then be recovered on ground, and the samples will be retrieved and distributed to scientists via a curation facility.

By the time of the presentation of this paper, the study will be in the industrial assessment phase. The latest status will be presented in this talk.



**Figure 1 – The logo of the Marco Polo Concurrent Design Facility study.**