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MARCOPOLO-R: ESA SAMPLE RETURN MISSION TO 2008 EV5 (A POTENTIALLY HAZARDOUS ASTEROID)

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ABSTRACT

MarcoPolo-R is a sample return mission to a primitive Near-Earth Asteroid (NEA) selected for a second Assessment Study Phase in the framework of ESA's Cosmic Vision (CV) programme. The new assessment study, started at ESA on May 2011, will continue until the end of 2013, when ESA will finally select the M3 class mission for launch. MarcoPolo-R is a European-led mission with a possible contribution from other agencies. MarcoPolo-R will rendez-vous with a primitive NEA, scientifically characterize it at multiple scales, and return a unique sample to Earth unaltered by the atmospheric entry process or terrestrial weathering.

The mission will answer to the fundamental CV questions "How does the Solar System work?" and "What are the conditions for life and planetary formations?". Moreover these small bodies also represent both a potentially rich resource for future space exploration and a threat to the very existence of humankind on Earth. MarcoPolo-R will allow characterizing a member of the population of Potentially Hazardous Asteroids (PHA), which is of high interest for mitigation studies. It will return bulk samples from an organic-rich primitive asteroid to Earth for laboratory

analyses, allowing us to explore the origin of planetary materials and initial stages of habitable planet formation.

New observational data led the ESA Science Study Team, supported by their relevant scientific communities and associated working groups, to change the baseline target from the binary Near-Earth Asteroid 1996FG3 (now kept as a back up) to 2008 EV5. Observed properties of this object indicate that it will allow addressing in an unique manner the key science related to surface sampling from a primitive asteroid to Earth. In effect, 2008 EV5, with a diameter of about 400 m (Bush et al. 2011, Icarus 212, 649), has a moderate higher albedo (0.10-0.12) compared to other primitive objects to be visited by a sample return mission (NASA OSIRIS-REx, JAXA Habayusa 2). The spectrum is typical of primitive C-type asteroids and shows a spectral feature at 0.48 micron, which is a signature of the presence of alteration minerals with similarity to the CI meteorite Orgueil (Reddy et al. 2012, Icarus in press). Therefore it is likely that this body is particularly primitive in nature, has accreted in a volatile-rich region, and it may represent a transitional object between comets and asteroids.

The PHA 2008 EV5, which was also used as a potential target for human exploration mission, offers a very efficient operational and technical mission profile, with a complete mission scenario (round-trip) of 4.5 years with optimal launch windows in 2022-24. The mission analysis performed by ESA and by industries showed optimum launch opportunities to this target and a cost reduction of the mission compared to a mission to other potential targets. The reduced mission duration will bring the time of the sample analysis closer to the expected return epoch of other sample return missions, allowing Europe to contribute in a timely manner to the international sample return activities.

The baseline mission scenario of MarcoPolo-R to 2008 EV5 is as follows: a single primary spacecraft, carrying the Earth re-entry capsule and sample acquisition and transfer system, will be launched by a Soyuz-Fregat rocket from Kourou. The scientific payload includes state-of-the-art instruments, e.g. a camera system for high resolution imaging from orbit and on the surface, spectrometers covering visible, near-infrared and mid-infrared wavelengths, a radio science experiment. Several other optional instruments are under analysis at ESA, such as a small Lander equipped with a radar tomographer, which will add to the in-situ characterization close to the sampling site, and allow for the first time the internal structure investigation of a NEA, which is of high relevance for mitigation studies.

The development of sample return technology represents a crucial element for Europe's science community and space industries to remain at the level of other main agencies developing these capabilities. The sample will provide a legacy for future generations of scientists with the potential for application of new analysis techniques and instrumentation to address as yet unexplored aspects of planetary science. In addition to addressing the exciting science goals, the MarcoPolo-R mission also involves innovative European technologies for which ESA technical development programs are well under way that can be used as pathfinder of other future missions for science, human exploration and particularly for mitigation.