EPSC Abstracts
Vol. 13, EPSC-DPS2019-1536-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Asteroid In-situ Interior Investigation - 3way: Understanding the formation processes and evolution of small solar system bodies

J. F. Deller (1, 2*), Esa Vilenius(2), Olaf Roders(2), Özgür Karatekin(3), Sampsa Pursiainen(4), Koji Wada(5), Paolo Tortora(6) Tomáš Kohout(7), Jessica Agarwal(2), Paul Abell(8), Tom Andert(9), Marina Brozovic(10), Kieran Carroll(11), Graciela G. Peytaví(9), Martin Jutzi(12), Naomi Murdoch(13), Thomas Müller(14), Nuno Peixinho(15), Birgit Ritter(3), John-Robert Scholz(2), Liisa-Ida Sorsa(4), Mika Takala(4), Giacomo Tommei(16), Peter Vereš(17), Robert Wimmer-Schweingruber(1), Marco Zannoni(6), Masahiko Arakawa(18), Takanao Saiki(19), Ryo Ishimaru(5), Yutaka Wada(5), Hans Martin Braun(20), Francisco da Silva Pais Cabral(21), Hannah Goldberg(22), Antti Näsilä(23), Fredrik Sjoberg(24), Manfred Wittig(25), and Patrick Bambach(2)

(1) University of Kiel (Leibnizstrasse 11, 24118 Kiel, Germany)
(2) Max Planck Institute for Solar System Research (Justus-von-Liebig-Weg 3, D-37077 Göttingen)
(3) Royal Observatory of Belgium, Belgium
(4) Tampere University, Finland
(5) Chiba Institute of Technology, Japan
(6) University of Bologna, Italy
(7) University of Helsinki, Finland
(8) NASA, USA
(9) Bundeswehr University in Munich, Germany
(10) JPL, USA
(11) Gedex Systems Inc, Canada
(12) University of Bern, Switzerland
(13) University of Toulouse, France
(14) MPI for extraterrestrial physics, Germany
(15) Nuno Peixinho, CITEUC - Center for Earth and Space Science Research of the University of Coimbra, Portugal
(16) University of Pisa
(17) Harvard-Smithsonian Center for Astrophysics (USA)
(18) Kobe University, Japan
(19) ISAS/JAXA, Japan
(20) RST Radar System Technik, Germany
(21) GMV, Spain,
(22) GOMSpace, Denmark
(23) VTT, Finland
(24) OHB, Sweden
(25) MEW, Germany

(*Email:deller@physik.uni-kiel.de / deller@mps.mpg.de)

Abstract

1. Mission Description

AI3, the “Asteroid In-situ Interior Investigation - 3ways” was submitted as a mission proposal for the 2018/19 ESA F-Class call and is currently in the final scientific evaluation process. The mission proposes to investigate the interior of a rubble pile asteroid with three different complementary measurements: radar tomography, determination of the gravity field, and seismic sounding. A hyperspectral imager provides detailed mineralogical maps of the surface.

A mothership serving as communication and radio-tracking relay will carry three CubeSats in the orbit of the target asteroid. Primary target is asteroid Apophis, a PHA that will have an extremely close

approach to Earth in 2029, where it is getting as close as 0.1 Lunar distances to the Earth. Detectable surface changes such as landslides are likely to occur during this flyby.

Two identical Deep-Interior Scanning CubeSats (DISCUS) satellites will be deployed. Besides providing full redundancy, this approach enables bi-static radar measurements and CubeSat-to-CubeSat Doppler measurements, significantly improving the reconstruction resolution and accuracy. The results will allow reconstructing the interior by using computed tomography combining both data of the gravity field and the variation of dielectric properties. The surface mineralogy provides critical context to connect these models to material properties such as the interior composition.

After finalizing the global characterization phase, one of the DISCUS CubeSat will descent to the surface and measure the local surface gravity on the asteroid.

Within 24 hours of the landing, an impactor based on the successful Hayabusa2/SCI will be deployed to impact the surface with at least 1MJ kinetic energy, similar to the SCI impact, adding a cratering experiment in a so far not well known energy regime. The seismic wave produced by this event will be detected by the landed DISCUS D1 CubeSat, and provide an additional channel to reconstruct the interior of the asteroid. The second D2 CubeSat will observe the impact event with high spatial and temporal resolution, providing important information about the sub-surface structure.

The mission will be co-launched with the ARIEL mission. The total close-proximity operation time, shown in Figure 1, is foreseen to take 6 month.

Combining the interior measurements with the spectral and optical surface configuration will allow us to draw conclusions on the formation process and mechanisms of small solar system bodies.

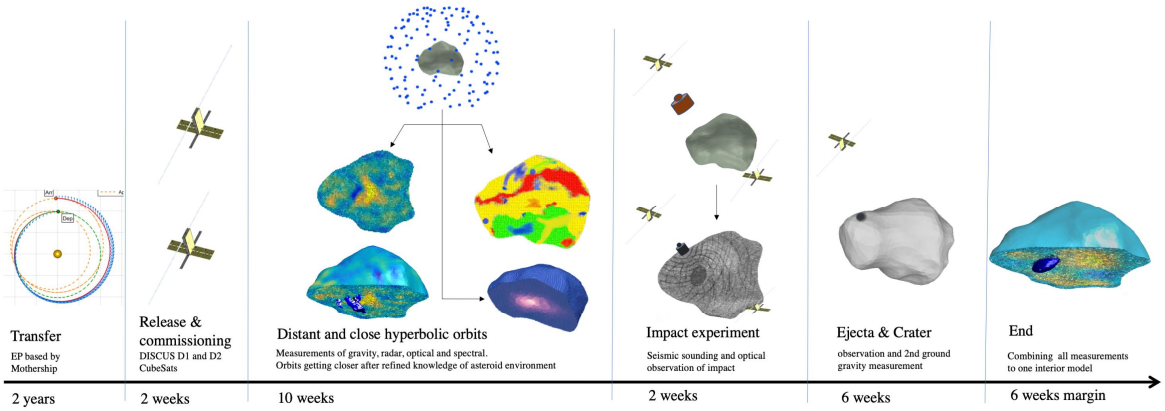

Figure 1 Timeline of close-proximity operation plan for AI3