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SEE A NEW WORLD IN 17 HOURS – FIRST RESULTS, DESIGN AND MISSION OF THE MOBILE ASTEROID SURFACE SCOUT (MASCOT) ON RYUGU

Tra-Mi Ho[(1)]*, Volodymyr Baturkin[(1)], Ross Findlay[(13)], Christian D. Grimm[(1)], Jan Thimo Grundmann[(1)#], Catherin Hobbie[(1)], Eugen Ksenik[(1)], Caroline Lange[(1)], Kaname Sasaki[(1)], Markus Schlotterer[(1)], Maria Talapina[(1)], Nawarat Termtanasombat[(13)], Elisabeth Wejmo[(13)], Lars Witte[(1)], Michael Wrasmann[(1)], Guido Wübbels[(1)], Johannes Rößler[(1)], Christian Ziach[(13)], Jens Biele[(2)], Christian Krause[(2)], Stephan Ulamec[(2)], Michael Lange[(3)], Olaf Mierheim[(3)], Roy Lichtenheldt[(4)], Maximilian Meier[(4)], Josef Reill[(4)], Hans-Jürgen Sedlmayr[(4)], Pierre Bousquet[(5)], Aurélie Moussi-Soffys[(5)], Anthony Bellion[(5)], Olivier Bompis[(5)], Céline Cenac-Morthe[(5)], Muriel Deleuze[(5)], Stephane Fredon[(5)], Eric Jurado[(5)], Elisabet Canalias[(5)], Ralf Jaumann[(6)], Jean-Pierre Bibring[(7)], Karl Heinz Glaßmeier[(8)], David Herčík[(8)], Matthias Grott[(6)], Luca Celotti[(9)], Federico Cordero[(10)], Jeffrey Hendrikse[(11)], Tatsuaki Okada[(12)]

[(1)]DLR (German Aerospace Center), Institute of Space Systems, Robert-Hooke-Str. 7, 28359 Bremen, Germany
**+49-(0)421-24420-1171, Tra-Mi.Ho@dlr.de*
[#]presenting co-author: +49-(0)421-24420-1107, Jan.Grundmann@dlr.de
[(2)]DLR, Space Operations and Astronaut Training, MUSC, Linder Höhe, 5147, Köln, Germany
[(3)]DLR, Institute of Composite Structures and Adaptive Systems, Lilienthalplatz 7, 38108 Braunschweig, Germany
[(4)]DLR, Robotic and Mechatronics Center, Münchener Straße 20,82234 Oberpfaffenhofen-Wessling, Germany
[(5)]CNES, 18 Avenue Edouard Belin, 31400 Toulouse, France
[(6)]DLR, Institute of Planetary Research, Rutherfordstrasse 2, 12489 Berlin-Adlershof, Germany

[7]IAS, Université Paris Sud - Bat 121, 91405 ORSAY CEDEX, France
[8]Technische Universität Braunschweig, Mendelssohnstraße 3, 38106 Braunschweig, Germany
[9]Active Space Technologies GmbH, Carl-Scheele-Strasse 14, 12489 Berlin
[10]Telespazio-Vega, Europaplatz 5, 64293 Darmstadt, Germany
[11]Airbus DS, 88039 Friedrichshafen, Germany
[12]ISAS/JAXA, 3-1-1 Yoshinodai, Sagamihara, JAPAN
[13]consultants to DLR Institute of Space Systems

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ABSTRACT

On October 3rd, 2018, 01:58 a.m. UT, the Mobile Asteroid Surface Scout, MASCOT, was released by JAXA's HAYABUSA2 spacecraft from an altitude of ~50 m. It gently descended in free fall to the rugged surface of C-type near Earth, potentially hazardous asteroid (NEA, PHA) (162173) Ryugu. After a few bounces, the lander came to rest at the surface and started to perform its scientific investigations of surface structure, mineralogical composition, thermal behavior and magnetic properties by operating its four scientific instruments. Those included a hyperspectral short wave-IR imaging microscope spectrometer (MicrOmega, IAS Paris), a high dynamic range wide-angle camera with colour illumination (MasCAM, DLR Berlin), a multispectral thermal IR radiometer (MARA, DLR Berlin) and a magnetometer (MasMAG, TU Braunschweig). MASCOT operated for more than 17 hours on 3 asteroid days from a non-rechargeable battery, beyond the last loss of signal at 19:11 UT.

MASCOT was developed by the German Aerospace Centre (DLR) in collaboration with the Centre National d'Etudes Spatiales (CNES). Built in only 2 years from PDR to FM delivery, it was launched on December 3rd, 2014, aboard the HAYABUSA2 spacecraft to its journey involving an Earth gravity-assist and extensive ion propulsion operations. Aboard HAYABUSA2, it is accompanied by 3 Japanese MINERVA-II landers, 2 of which were released on September 22nd, 2018, and conduct long-duration photovoltaic-powered activities at a landing site antipodal to MASCOT's. All share a common communication infrastructure with HAYABUSA2.

Similar to its famous predecessor mission HAYABUSA at S-class PHA (25143) Itokawa, HAYABUSA2 extensively studies its target and will return samples to Earth of an asteroid which is considered to be more primitive and expected to provide insight into an even earlier stage of our Solar System. MASCOT provides ground truth for HAYABUSA2 and from its unique perspective the bridge between the size scales of the samples to be returned, expected to be nm- to mm-scale mineral grains, and remote observation in the cm- to km-scale.

For optimized payload operations an optimized thermal design was required to cope with the contrasting requirements of the 4-year cruise in cold environment necessary to preserve battery charge versus the warm conditions on the surface of the asteroid. The mobility mechanism allowed locomotion on the surface. It was used 4 times to self-right, relocate, and move MASCOT. It is supported by an attitude and motion sensing system and an intelligent autonomy manager, which is implemented in the

onboard Software. Thus, MASCOT could continue to operate efficiently when ground contact was not available while HAYABUSA2 was below the local horizon at night.

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