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MASCOT2, a Lander to Characterize the Target of an Asteroid Kinetic Impactor Deflection Test Mission

Jens Biele[(1)*], Stephan Ulamec[(1)], Christian Krause[(1)], Barbara Cozzoni[(1)], Caroline Lange[(2)], Jan Thimo Grundmann[(2)], Christian Grimm[(2)] Tra-Mi Ho[(2)], Alain Herique[(3)], Dirk Plettemeier[(4)], Matthias Grott[(5)], Hans-Ulrich Auster[(6)], David Herčík[(6)], Ian Carnelli[(7)], Andrés Galvez[(7)], Christian Philippe[(8)], Michael Küppers[(9)], Björn Grieger[(9)], Jesus Gil Fernandez[(9)], Jerzy Grygorczuk[(10)], Marta Tokarz[(10)] and Simon Tardivel[(11)]

[(1)]*DLR German Aerospace Center, RB – MUSC, 51147 Köln, Germany,*
** corresponding author: +49-2203-6014563, jens.biele@dlr.de*
[(2)]*DLR German Aerospace Center, Institute of Space Systems, 28359 Bremen, Germany*
[(3)]*Univ. Grenoble Alpes, IPAG, F-38000 Grenoble, France*
[(4)]*Technical University Dresden, 01187 Dresden, Germany*
[(5)]*DLR German Aerospace Center, Institute of Planetary Research,12489 Berlin, Germany*
[(6)]*Institute for Geophysics and Extraterrestrial Physics, Technical University Braunschweig, Germany*
[(7)]*ESA European Space Agency, HQ, Paris, France*
[(8)]*ESA European Space Agency, ESTEC, Noordwijk, The Netherlands*
[(9)]*ESA European Space Agency, ESAC, Spain*
[(10)]*ASTRONIKA Sp. z o.o., 00-716 Warszawa, Poland*
[(11)] *University of Colorado Boulder, 80309 Boulder, United States*

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ABSTRACT

In the course of the AIDA/AIM mission studies[1,2] a lander has been studied to be deployed on the moon of the binary Near-Earth Asteroid system, 65803 Didymos.
The AIDA technology demonstration mission, composed of a kinetic impactor, DART, and an observing spacecraft, AIM, has been designed to deliver vital data to determine the momentum transfer efficiency of the kinetic impact and key physical properties of the target asteroid. This will enable derivation of the impact response of the object as a function of its physical properties, a crucial quantitative point besides the qualitative proof that the asteroid has been deflected at all.

A landed asset on the target asteroid greatly supports analyzing its dynamical state, mass, geophysical properties, surface and subsurface structure. The lander's main instrument is a bistatic, low frequency radar (LFR)[3] to sound the interior structure of

[1] *Cheng, A. F., J. Atchison, et al. (2015). "Asteroid impact and deflection assessment mission." Acta Astronautica **115**: 262-269.*
[2] *Michel, P., A. Cheng, et al. (2016). "Science case for the Asteroid Impact Mission (AIM): A component of the Asteroid Impact & Deflection Assessment (AIDA) mission." Advances in Space Research(57): 2529-2547.*
[3] *Herique, A. and V. Ciarletti (2016). A Direct Observation of the Asteroid's Structure from Deep Interior to Regolith: Two Radars on the AIM Mission. 47th Lunar and Planetary Science Conference.*

the asteroid. It is supported by a camera (MasCAM)[4], a radiometer (MARA)[5], an accelerometer (DACC), and, optionally, also a magnetometer (MasMAG)[6].
MASCOT2 is a small (~13kg) lander, based on the design of MASCOT[7,8] which is part of the Hayabusa2 mission.
The lander will be deployed from the mother spacecraft and soft-land on ”Didymoon”. After several bounces and likely re-location and self-righting by an internal mobility mechanism, it will operate for several months on the asteroid surface and provide detailed information about its landing site and the physical properties of the surface material. Its operational concept shall enable an internal structural analysis of Didymoon before and after the impact. Besides the lander unit of the LFR, a camera will provide high-resolution images of the landing area, and accelerometers will interpret the bouncing dynamics. During the DART impact, MASCOT2 will possibly be able to detect the seismic shock with its accelerometers. Exact timing could give valuable information on the internal structure (from the velocity of p-waves).
MASCOT2 will also serve as a technology demonstrator for asteroid landing and extended operations, powered by a solar generator imounted on deployable panels.
We describe the science concept, mission analysis, foreseen deployment utilizing three-body dynamics, the selected instruments, the operational timeline, and the latest status of the lander’s design on the background of the MASCOT, its highly responsive Concurrent Engineering (CE) & AIV approach supported by Model-Based System Engineering (MBSE).
AIM funding has not been fully confirmed by ESA Member States during the ESA ministerial council meeting in 2016, yet the concept of MASCOT2 stays valid. With appropriate tailoring and optimization to the respective mission, it will be considered for future missions.

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[4] *R. Jaumann, N. Schmitz, A. Koncz, et al. (2016), The Camera of the MASCOT Asteroid Lander on Board Hayabusa2; Space Science Reviews, DOI 10.1007/s11214-016-0263-2*
[5] *M. Grott, J. Knollenberg, et al. (2016), The MASCOT Radiometer MARA for the Hayabusa 2 Mission, Space Science Reviews, DOI 10.1007/s11214-016-0272-1*
[6] *David Herčík, Hans-Ulrich Auster, et al. (2016), The MASCOT Magnetometer; Space Science Reviews, DOI 10.1007/s11214-016-0236-5*
[7] *Ulamec, S. and J. Biele (2015). Relevance of PHILAE and MASCOT In-Situ Investigations for Planetary Defense. IAA Planetary Defense Conference. Frascati, Italy.*
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