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On Time, On Target – How the Small Asteroid Lander MASCOT Caught a Ride Aboard HAYABUSA-2 in 3 Years, 1 Week and 48 Hours

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ABSTRACT

Delayed only 3 days by weather, the small asteroid lander MASCOT was launched aboard the Japanese HAYABUSA-2 asteroid sample-return mission on December 3rd, 2014, 04:22 UT, within the first interplanetary launch window. Their target is the near-Earth asteroid (162173) 1999 JU_3. The fully autonomous MASCOT carries four asteroid science instruments, orientation sensors, and an uprighting/relocation mechanism within a shoebox-sized 10 kg spacecraft. Though only an instrument-sized lander, its complexity is comparable to a similarly equipped standalone spacecraft.
MASCOT is a fast paced high performance project, developed under strict constraints of volume, mass, available personnel, budget, and accessible infrastructures, to a timely deadline of a celestially fixed launch date. With a model philosophy tailored 'live' at system level, it integrates a unique mix of conventional and tailored model philosophies at units level. A dynamically adapted test programme using Concurrent Assembly Integration and Verification (AIV) kept project risk within acceptable bounds and shortened the system-level AIV phase from the typical 4 to 5 year to 2½ years within a project timeline of 3 years focused on the specific launch opprotunity. Here, MASCOT benefited from a preceding phase of a range of lander concept studies at the DLR Bremen Concurrent Engineering Facility since 2008. Within the 3 years project timeline, from the first integrated breadboard model (½ year after first unit-level hardware breadboarding) the MASCOT team has successfully completed approx. 30 MASCOT system level tests, more than 50 additional subunit tests (excluding payloads) as well as approx. 10 test campaigns on its carrier satellite Hayabusa-2. This culminates in almost 100 different

test campaigns performed in roughly half the time allocated for such a prototype project which would have followed a standardized way.
MASCOT provided useful lessons in assembly, integration, testing and its related management that could be applied to increase the efficiency and decrease the lead time of future interplanetary projects from concept to launch. These lessons may become vital when the first sizeable Earth-impacting asteroid is discovered *before* its terminal dive.
Currently, the MASCOT Flight Spare is planned to be used as Ground Reference Model and to continue functional and environmental testing on system level throughout the first half of 2015. It will be joined by still to be (re-)built partial hardware models for software and operations development. Also, some subsystem test campaigns necessary for optimized operations planning are ongoing or are being planned. All these expand the experience base for future MASCOT activities, and ultimately, for the few precious hours of the asteroid surface science mission of the Flight Model – the one out there of the many.

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