

MASCOT – a Mobile Lander on-board Hayabusa2 Spacecraft – Status and Operational Concept for the Asteroid Ryugu

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MASCOT ('Mobile Asteroid Surface Scout') is a 10 kg mobile surface science package on board JAXA's Hayabusa2 sample return mission, currently on its way to the near-Earth asteroid (162173) Ryugu. The mission was launched in December 2014 from Tanegashima Space Center, Japan. The Hayabusa2 spacecraft will reach the target asteroid in summer 2018. Hayabusa2 will return its samples to Earth in December 2020.

After arrival at the target asteroid 'Ryugu' a detailed mapping phase will be performed and the landing site of MASCOT will be selected. The deployment of MASCOT to the asteroids surface is planned for the beginning of October 2018.

MASCOT has been developed by the German Aerospace Center (DLR) in cooperation with the Centre National d'Etudes Spatiales (CNES). The main objective of MASCOT is to perform in-situ investigations of the asteroid surface and to support the sampling site selection for the mother spacecraft.

Mascot is equipped with four scientific instruments a wide angle camera, a hyperspectral infrared microscope, a radiometer and a magnetometer. The camera (MasCam) provides ground truth for the orbital measurements of the Hayabusa2 orbiter instruments and the in-situ MASCOT sensor suite as well as geological context of the samples. The radiometer (MARA) determines the surface brightness temperature, the thermal inertia of the surface material and the spectral slope in infrared. The radiometer field of view is correlated with the wide angle camera field of view. The magnetometer (MasMAG) observes the magnetic field profile during descent and bouncing and determines any global and local magnetization of the asteroid.

The hyperspectral IR microscope (MicrOmega) identifies the composition of the asteroidal surface at grain scale: in terms of minerals (pristine, altered), ice/frosts, and organics and characterize the microscopic structure of the soil.

MASCOT is powered by a primary battery which shall enable it to investigate the asteroid surface for up to two asteroid days. MASCOT is further equipped with a mobility mechanism for self-righting and relocation on the asteroid surface. Since MASCOT has the shape of a shoe box and no dedicated landing gear, it is not predefined which side would face the asteroid once it comes to rest. GNC sensors will determine the orientation of MASCOT relative to the asteroid surface and the mobility mechanism will be used to upright MASCOT in its default measurement orientation. The communication of MASCOT to Earth will take place via Hayabusa2 spacecraft.

For the deployment of MASCOT, the Hayabusa2 spacecraft will descent from its home position 20 km above the asteroid to a very low altitude of about 60 m over the Ryugu's surface. MASCOT will be separated from the mother spacecraft and its science activities will already start during the descent phase. After first contact with the asteroid surface MASCOT will bounce several times until it comes to rest. After detection of MASCOT's orientation and autonomous self-righting with the mobility mechanism the scientific surface operations will start. Hayabusa2 will ascent and hover above the asteroid surface near the sub-solar point. MASCOT will operate autonomously without visibility to its mother spacecraft during the asteroid's night. After a full measurement sequence of all scientific instruments during the asteroid rotation MASCOT is able to relocate itself on the asteroid surface using its mobility mechanism. At the new site MASCOT will determine again its orientation and perform self-righting in its default measurement orientation and science surface sequences get started. In this way different sites on the surface of Ryugu can be investigated. The MAM (MASCOT Autonomy Manager) will schedule pre-defined and pre-tested sequences for sciences and system activities. The MASCOT system and its operational concept are designed to enable an optimum science return within its lifetime, which is driven by the capacity of the primary battery.

Hayabusa2 is currently on its way to Ryugu. During the four years cruise time different status checks and instrument calibrations have been performed. The planning and preparation for the On-Asteroid activities incl. descent and landing take place in cooperation with the Hayabusa2 team.

The presentation will provide an overview of the MASCOT system and its operational concept, the activities during cruise and will further focus on the planned activities for the asteroid phase starting in summer 2018 after Hayabusa2 arrival at Ryugu.