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## MASCOT en route to Asteroid 1999 JU3

*03 December 2014*

Philae landed on a comet just three weeks ago; now, another German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) lander mission has been launched – the Mobile Asteroid Surface Scout (MASCOT) is already on its way to Asteroid 1999 JU3. On 3 December 2014 at 05:22 CEST, an H IIA launch vehicle lifted off from the Tanegashima Space Center and the Hayabusa 2 spacecraft and its MASCOT lander began their journey through space. It will take them roughly four years to reach their target. Once there, Hayabusa 2, a project of the Japanese Space Agency (Japan Aerospace Exploration Agency; JAXA), will 'vacuum up' surface material from orbit above the asteroid and return it to Earth. MASCOT, on other hand, will descend to the surface of Asteroid 1999 JU3, move around by 'hopping' and perform measurements at several locations on an asteroid for the first time in the history of spaceflight. The lander, developed and constructed at DLR, together with its four instruments, will be monitored and controlled from the 'MASCOT Control Center' at DLR Cologne during the journey and work on the asteroid.

Hayabusa 2 and MASCOT will arrive at Asteroid 1999 JU3, which has a diameter of approximately one kilometre, in the summer of 2018. On the way there, they will perform a swing-by around Earth in winter 2015 to increase their velocity. Upon arrival, the spacecraft will first map the surface of 1999 JU3 before approaching the asteroid to take samples early in 2019. Then, MASCOT will free fall onto the asteroid from a height of 100 metres. "The biggest challenges are the separation from the mother spacecraft and the subsequent landing," says Project Leader Tra-Mi Ho from the DLR Institute of Space Systems. "Nobody knows the exact gravitational pull of the asteroid." 1999 JU3 is particularly rich in carbon and thus belongs to a frequently occurring class of asteroids, but there is a great deal that scientists do not yet know about it.

### **Four instruments**

In 2019, the asteroid researchers will have up to 16 hours to gather data that they have never previously been able to acquire. The lander battery, a contribution from the French Space Agency (Centre National d'Etudes Spatiales; CNES), will be empty after two asteroid days and nights; this will signal the end of the lander mission, because it has no solar panels to recharge the battery. MASCOT could not weigh more than 10 kilograms – this was one of the requirements stipulated by the Hayabusa 2 team when DLR began the development of an asteroid lander to be carried on board. Not an easy task – the Philae lander, developed by a DLR-led consortium, weighs 100 kilograms; MASCOT had to just weigh one tenth of this. DLR engineers incorporated a total of four instruments into a very stable yet lightweight structure. A radiometer and a camera from DLR, as well as a spectrometer from the Institut d'Astrophysique Spatiale (IAS) and a magnetometer from the Technical University of Braunschweig will allow the mineralogical and geological composition of the asteroid surface to be examined and the surface temperature and magnetic field of the asteroid to be determined.

### **Up to 70-metre 'hops' on the asteroid**

The first landing on an asteroid, which was not originally planned, occurred in 2001 with NASA's Near Earth Asteroid Rendezvous – Shoemaker (NEAR Shoemaker) mission. The spacecraft examined the asteroid Eros for over a year from orbit and was then steered in the direction of the asteroid surface. NEAR Shoemaker landed surprisingly undamaged and remained there for 16 days, from 12 to 28 February 2001. MASCOT, on the other hand, is designed and equipped for landing on an asteroid. The shoebox-sized lander will use sensors to determine whether it has landed on its top or bottom. If necessary, the lander can use an internal swing arm to 'bounce' into the correct orientation and begin its measurements. Once all four instruments have

been used, MASCOT will automatically re-enable the swing arm and jump up to 70 metres to its next task. In addition to the instruments, the lander is equipped with a thermal control system to compensate for the varying temperatures on the asteroid and an onboard computer that sends the data obtained to the DLR control centre via Hayabusa 2.

### **Research in both field and laboratory**

The first JAXA Hayabusa mission was a success; in 2010, the Hayabusa 1 spacecraft used a capsule to deliver asteroid material in its original, unmodified form to Earth for the first time. At that time, the DLR Institute of Planetary Research also examined the rare particles. With the Hayabusa 2 mission, material will again be returned to Earth, but also be analysed locally by MASCOT. "Our data will be used, among other things, as a reference for the studies in terrestrial laboratories," says Tra-Mi Ho. In addition, the lander will act as a scout and explore where the Japanese probe is to collect the asteroid material from. "Spacecraft and lander together will greatly increase our knowledge of asteroids."

### **DLR participation in the Hayabusa 2 mission**

The DLR Institute of Space Systems developed the lander and tested it under space conditions during parabolic flights, in a drop tower, on a shaker and in a thermal vacuum chamber. The DLR Institute of Composite Structures and Adaptive Systems was responsible for the stable structure of the lander. The DLR Institute of Robotics and Mechatronics developed the swing arm that MASCOT will use to 'hop' on the asteroid. The DLR Institute of Planetary Research managed the development of the MASCAM camera and the MARA radiometer. The asteroid lander is being monitored and controlled from the Microgravity User Support Center (MUSC) in Cologne.

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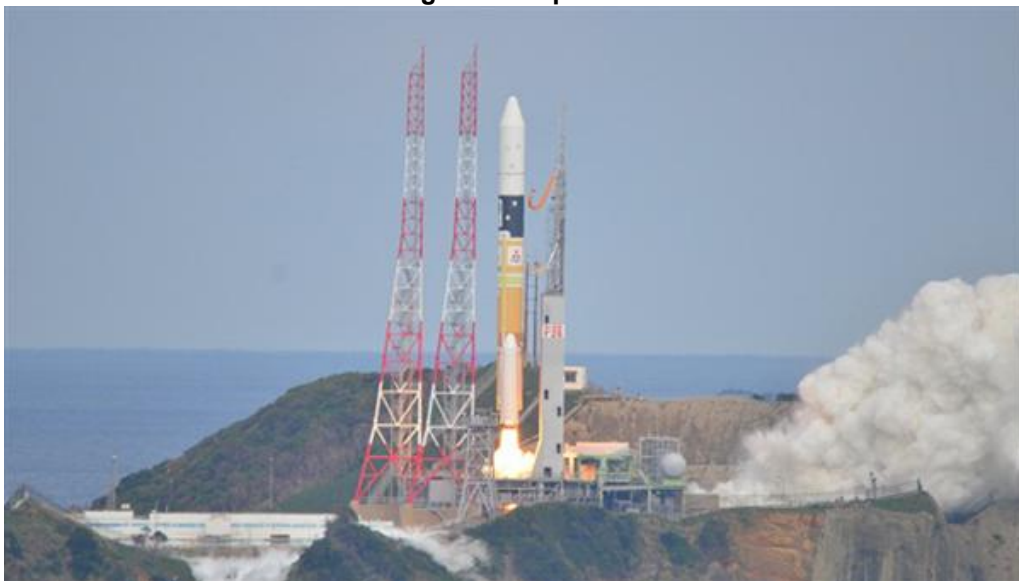
### **Contacts**

*Manuela Braun*  
German Aerospace Center (DLR)  
Media Relations, Space Research  
Tel.: +49 2203 601-3882  
Fax: +49 2203 601-3249  
[Manuela.Braun@dlr.de](mailto:Manuela.Braun@dlr.de)

*Dr Tra-Mi Ho*  
German Aerospace Center (DLR)  
DLR Institute of Space Systems  
Tel.: +49 421 24420-1171  
[Tra-Mi.Ho@dlr.de](mailto:Tra-Mi.Ho@dlr.de)

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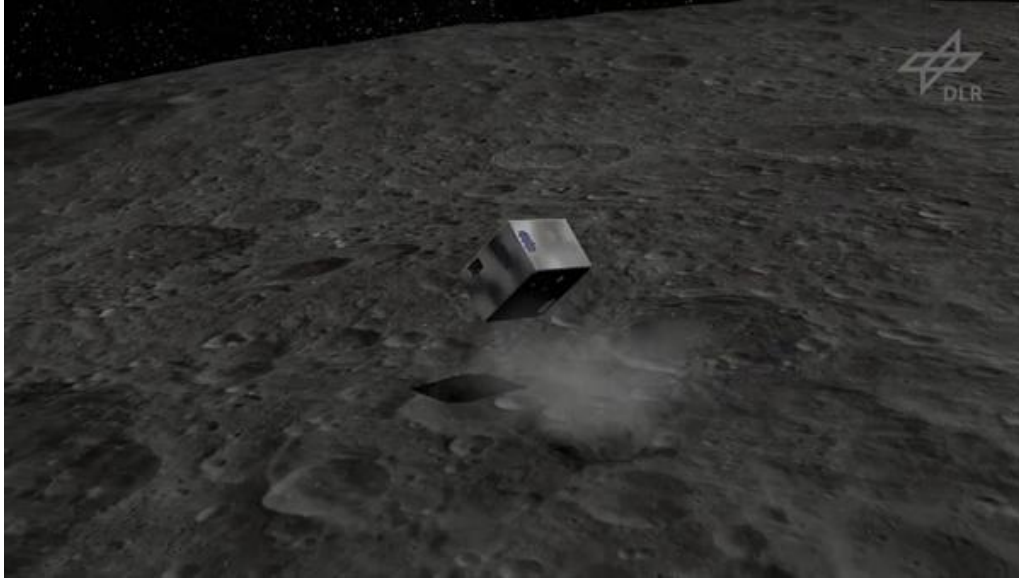
### **MASCOT launches from the Tanegashima Space Center**



On 3 December 2014 at 05:22 CEST, an H IIA launch vehicle lifted off from the Tanegashima Space Center and the Japanese Hayabusa 2 spacecraft and its MASCOT lander, developed by DLR, began their journey to Asteroid 1999 JU3.

Credit: MHI Global.

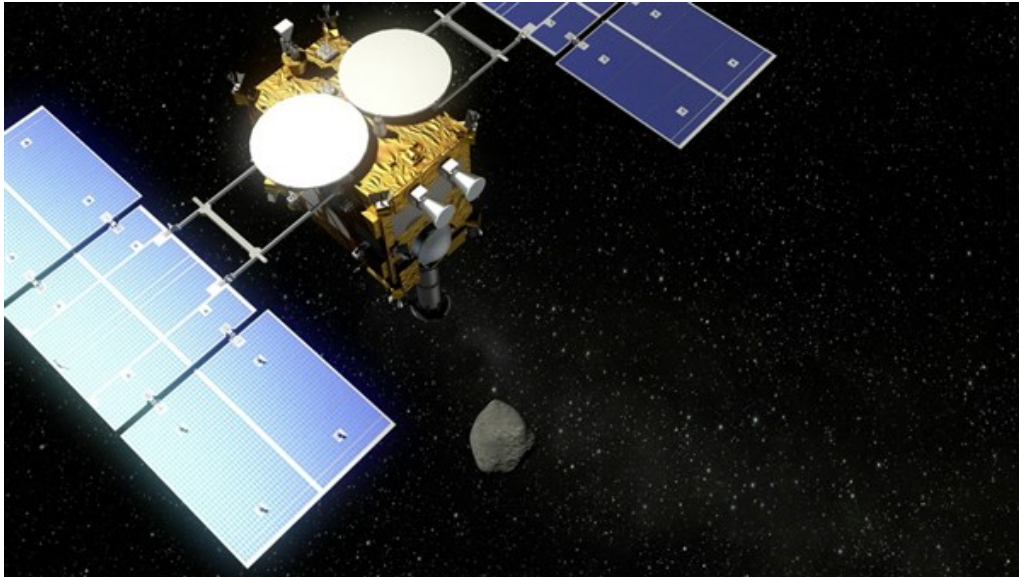
### **MASCOT – measurements on the surface of an asteroid**



In 2019, the DLR asteroid lander MASCOT will descend to the surface of Asteroid 1999 JU3 and perform measurements with four instruments. Using an internal swing arm, the lander will be able to move across the surface by 'hopping'. MASCOT is travelling to its destination on board the Japanese Hayabusa 2 spacecraft.

Credit: DLR (CC-BY 3.0).

### **Reconnaissance mission to an asteroid**



The Japanese Hayabusa 2 spacecraft will launch in 2014 to visit the asteroid 1999 JU 3. On board will be the German Aerospace Center (DLR) developed MASCOT (Mobile Asteroid Surface Scout), which will land on the asteroid and perform measurements with its four instruments.

Credit: DLR (CC-BY 3.0).

### Mobile asteroid surface scout (MASCOT)



MASCOT is a highly-integrated asteroid lander whose development was co-ordinated by DLR scientists collaborating with the French space agency CNES and the Japanese space authority JAXA.

Credit: DLR (CC-BY 3.0).

### Giving MASCOT the finishing touches



Engineers at the German Aerospace Center (DLR) assemble the MASCOT asteroid lander for the Japanese Hayabusa 2 spacecraft.

Credit: DLR (CC-BY 3.0).

## MASCOT – preparations for flight



The MASCOT asteroid lander, developed by the German Aerospace Center (DLR), is scheduled to launch in December 2014 on board the Japanese Hayabusa 2 spacecraft.

Credit: DLR (CC-BY 3.0).

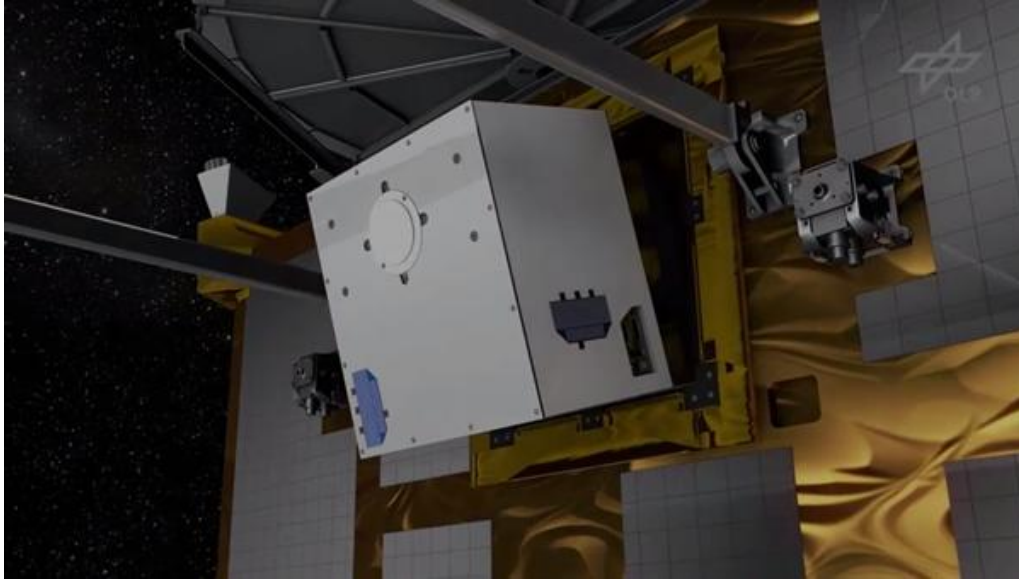
## MASCOT asteroid lander in microgravity



DLR researchers use parabolic flights to test the MASCOT asteroid lander's functions in microgravity. MASCOT is due to separate from the Japanese Hayabusa-2 spacecraft above asteroid 1999 JU 3 and fall to the surface.

Credit: DLR (CC-BY 3.0).

### Animation –MASCOT asteroid lander



The German Aerospace Center (DLR) MASCOT asteroid lander will launch in December 2014 on board the Japanese Hayabusa 2 spacecraft, with asteroid 1999 JU3 as its destination.

Credit: DLR.

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