Current status and future plan of MINERVA-II rovers onboard Hayabusa2

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Abstract

MINERVA-II is a rover payload installed in Hayaubsa2 spacecraft which was launched in 2014. The payload includes three rovers, two of which developed by the authors are packed into the same container. The two rovers will be deployed simultaneously onto the asteroid surface after the mother spacecraft has arrived at the target asteroid "Ryugu" in 2018. Before the arrival at the asteroid, the payload is activated once for two months in order to check the health status. The onboard software revision will also be made before the arrival. This poster presentation addresses the activities in 2015 after the launch as well as the future plan for the preparation of the proximity operation.

1 Rover outline

A rover payload called "MINERVA-II" has been installed in Hayabusa2 spacecraft. The payload included three rovers, two of which were developed by the authors. Two rovers are almost identical with slight differences on the surface thermal parameters and and the installed sensors.

The rovers can move over the microgravity environment on the target asteroid by hopping with a use of a torquer installed in the body. This hopping mechanism is just the same as the one we used for MINERVA rover in Hayabusa mission.

The solar cells of the surface generate about 2[W] to activate the onboard CPU and the communication module. The extra power is charged into the capacitors. The obtained data by the rovers are transmitted to the relay component of the mother spacecraft by a radio with a maximum speed of 32[kbps].

The rovers were developed for pursuing technical experiments, out of the scope of the stated scientific mission success criteria. Evaluation of hopping mobile system and demonstration of fully autonomous exploration are the two biggest technical challenges.

We do not forget about the scientific characterization of the asteroid. There are several possibilities by the installation of tiny sensors, by the ingenious operation method, and by the analysis on technical data.

The onboard software can be altered after the launch. Thus the autonomous capability can be brushed up after the launch.

2 Post-launch verification using a drop tower

Microgravity experiments using a drop tower were made after the launch in order to evaluate the hopping capability by the rover nd the deployment mechanism of the rover in flight configurations.

Four drops were provided on 20–23 April 2015 at ZARM in Bremen, Germany. This facility attained 4.7[sec] of micro-gravity by a free fall of 110[m]. The long capsule was used, in which both hopping and deployment experiments can accommodate together.

The deployment velocity of the rovers from the spacecraft as well as the hopping speed and direction of the rovers were measured using the prototype models. The measurements are used for the proximity operation of the rovers scheduled in 2018–2019.

3 Operation

We made several operations in 2015 and confirmed the payload was healthy so far.

Initial simple check after the launch was made in December 2014.

Second check campaign based on the realtime operations was provided in June–July 2015. Three tracking passes in three days were dedicated for the detailed investigation on the relay component and European MASCOT lander, of which communication modules were provided from us. Additional one tracking pass was assigned for the commanding operation on the rovers.

We made timeline-based operations in September and December 2015. All the commands related to

the payload were issued after the termination of the tracking from the ground, and everything was completed before the next tracking from the ground. The generated data were transferred to the data recorder of Hayabusa2 by the commanding operations.

This regular operation of the health check about the payload will be made once per two months using the timelines when Ion Engine System is not used.

Special operations about the onboard software updates must be made before the arrival at the asteroid. The relay component is enforced on the service to MASCOT lander and the rovers are sophisticated on the autonomous capabilities.

4 Conclusions

MINERVA-II is a rover payload installed in Hayaubsa2 spacecraft. The payload includes three rovers, two of which were developed by the authors.

We made several operations in 2015 after the launch to check the payload status. The recent operations were made based on the timelines where all the sequences were processed after the tracking from the ground. The data retrieval was made along with the commanding operation of the spacecraft. All the results showed that two rovers and the relay component were healthy so far.

We also made the microgravity experiments using a drop tower to evaluate the flight configuration of the rover and the deployment mechanism. The deployment velocity of the rovers from the spacecraft as well as the hopping speed and direction by the rovers were measured using the prototype models. The measurements will be used for the proximity operation of the rovers in 2018–2019.

Acknowledgement

The opportunity of the microgravity experiments at ZARM was provided from DLR by DLR-JAXA agreement on Hayabusa2.