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はやぶさ 2 レーザ高度計 LIDAR の初期運用
Initial operation of Hayabusa-2 laser altimeter (LIDAR)

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Introduction: As a successor of Japanese Hayabusa Asteroid mission, Hayabusa-2 was successfully launched on 3 December 2014. The target asteroid of Hayabusa-2 is now called 1999 JU_3, which has C-type spectral type. C-type asteroids are considered to be more primitive than S-type asteroids because of its further heliocentric distance, and to be good targets to know the origin and the history of the solar system.

As a part of the Attitude and Orbit Control Subsystem (AOCS), the laser altimeter called LIDAR is developed. LIDAR measures altitudes of the spacecraft from a surface of the asteroid by detecting a time of flight of bounced laser pulse on the asteroid surface. Basically the LIDAR data are used for navigation of the spacecraft, and they are particularly important during touchdown operation. Besides, the LIDAR data will be served for scientific analysis of the shape, mass, and surface properties of the asteroid in order to elucidate physical evolution of minor bodies such as impact fragmentation and coagulation.

In addition to the normal ranging mode, LIDAR of Hayabusa-2 is equipped with dust counting mode and laser transponder mode. The levitation dusts above the asteroid, if they exist, can be measured along the line of sight direction of the LIDAR in dust counting mode. The laser transponder mode is used for the demonstration of the optical data transmission from the spacecraft to the ground laser station and vice-versa, when the spacecraft is near the Earth for the Earth gravity assist operation in winter 2015.

Operation history: After the launch, the LIDAR was turned on for the first time on 15 December 2014 for the confirmation of the power consumption and thermal environment of the instrument. On 23 January 2015, detailed function test was done. On this day, all the necessary commands were issued and all observation modes were used. The whole ranging system was checked by turning on the laser and the detector unit for the first time after the launch. Because no ranging target is available during the cruise phase, each function was checked separately. First, the laser power is confirmed to be normal. Then, the high voltage of the APD (Avalanche Photo Diode) detector was applied properly, which was compensated with the temperature of the APD to stabilize the sensitivity. Also, the noise level of the APD was checked by changing the threshold level of the detectable signal. Lastly, the range-finding circuit was intentionally operated by detecting the stray light of the emitted laser by setting no dead time of the circuit. The dust mode and laser transponder mode were also confirmed to be normal. Besides, the quick look software of the LIDAR for monitoring the housekeeping data and data reduction has been developed, and the function was also confirmed in the initial checkout.

Future plan: The first chance of light detection will be realized as an experiment on the laser transponder mode before and after the Earth gravity assist in winter 2015. In this opportunity we can evaluate whether the alignment of the transmitting and receiving telescope keeps the required alignment position for ranging after the shock of the launch. The link budget of the laser can be also tested in this experiment.

After the Earth gravity assist operation, the spacecraft will be inserted into the transfer orbit, and it will arrive at the target asteroid in the middle of 2018 and the ranging with the LIDAR will start.

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