

Small carry-on impactor of Hayabusa2

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A Japanese spacecraft, Hayabusa2, the successor of Hayabusa, which came back from the Asteroid Itokawa with sample materials after its 7-year-interplanetary journeys, is a current mission of Japan Aerospace Exploration Agency (JAXA) and scheduled to be launched in 2014. Hayabusa2 is a similar sample return mission to Hayabusa, however the type of the target asteroid is different from that of Hayabusa. Asteroid Itokawa, explored by Hayabusa is a rock-rich S-type one. Hayabusa2 will go to a C-type asteroid. Both C-type and S-type asteroids consist of rocks, but C-type asteroids are considered to have organic and water materials. Hayabusa2 has two objectives to discover: organic matters and water in the solar system and relationship between life and ocean water. C-type asteroids are the most common variety and many of them are in the outer part of the asteroid belt beyond 2.7 AU. An asteroid, called 1999 JU3, is chosen as the target of Hayabusa2 mission because it is considerably easy to reach. It has a similar orbit as that of Itokawa and it is in the orbit that occasionally comes close to the earth orbit.

The design of Hayabusa2 basically follows Hayabusa. Its configuration, size and weight are almost same as Hayabusa and the touch-down operation will be performed in much the same way. However, it is planned to be equipped with some new components. Small Carry-on Impactor (SCI) is one of the new challenges. The observations by Hayabusa discovered that Itokawa was rubble-pile body with the macro-porosity. No direct observational data as for their internal structures and sub-surface materials were available, however. One of the most important scientific objectives of Hayabusa2 is to investigate chemical and physical properties of the internal materials and structures in order to understand the history of formation of small bodies such as small, un-differentiated asteroids. In order to achieve this objective, the SCI is required to remove the surface regolith and create an artificial crater on the surface of the asteroid. Different from other impact missions, Hayabusa2 can make a detailed observation of the resultant crater after the impact. Observing the size of the crater is very important to investigate the physical properties of the asteroid. Additionally, Hayabusa2 will try to touchdown near the crater to get the fresh material of the asteroid.

It is very difficult to create a meaningful crater on the asteroid. High kinetic energy (i.e. about 2km/s impact speed and 2kg impact mass) is required to make a crater, but the high speed is difficult to realize. The famous impact mission, Deep Impact was the direct impact mission, which used the interplanetary velocity for the impact speed. Consequently, the impact energy became very high. On the other hand, SCI of Hayabusa2 is a carry-on type impactor and it should accelerate itself after the separation from the mother spacecraft. Therefore, how to accelerate the impact body is a big challenge of SCI. The traditional acceleration devices such as rocket motors and thrusters are difficult to hit the asteroid without a guidance system because the acceleration distance is large. To overcome this difficulty, the powerful explosive is use in SCI. The special type of shaped charge makes it possible to accelerate the impact head in a very short amount of time (less than 1 millisecond) and it becomes possible to crash into the asteroid.

The development of SCI is now almost finished. A lot of tests were conducted during the development period. The overview of the small carry-on impactor system and the results of the development tests will be presented in the conference.

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