TRAJECTORY DESIGN FOR JAPANESE NEW ASTEROID SAMPLE RETURN MISSION HAYABUSA-2

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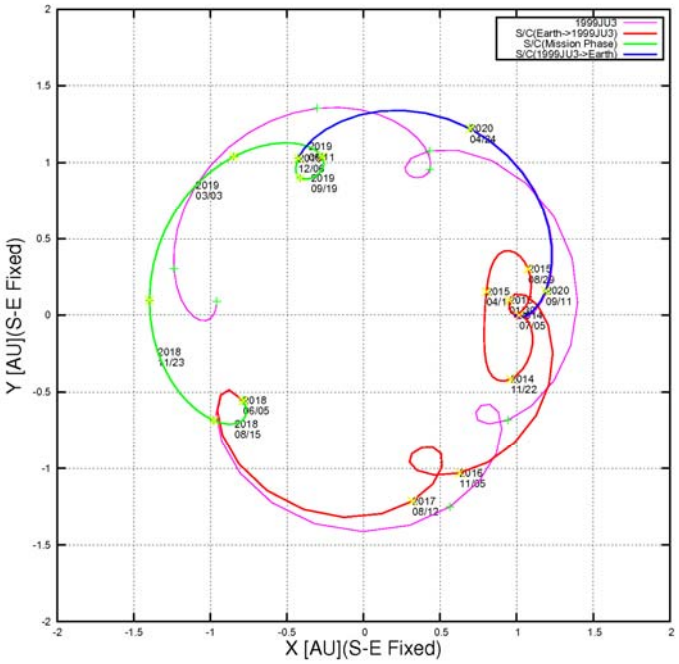
ABSTRACT

The Japan Aerospace Exploration Agency is now developing the second asteroid sample return mission "Hayabusa-2." Following the dramatic return back of Hayabusa from the asteroid Itokawa, Hayabusa-2 aims at the round trip mission to the asteroid 1999 JU3.1999 JU3 is a C-type asteroid, which is supposed to contain organic matters and hydrated minerals. Thus it is expected that, after the successful sample collection, we could acquire more knowledge on the origin and evolution of the planets, especially the origin of water and organic matters. Hayabusa-2 is to be equipped with four 10mN-class ion engines to provide efficient continuous thrust capability, and to make this round trip mission possible.
The trajectory design is one of the most important processes in the early phase of interplanetary mission design. In the mission design of Hayabusa-2, the trajectory assessment has contributed to the creation of the mission scenario in mainly two ways.
First example is an incorporation of the cratering mission. One of the highlights of the mission is that, Hayabusa-2 aims not only at touching down and sampling the soil of the asteroid, but also at creating a crater so that fresh soil in the subsurface could directly be observed and sampled. Our trajectory assessment concluded that there are three scenarios to realize the cratering mission, all of which were technically possible but different in the expected crater size as well as the investment cost level.
Second example is the target asteroid selection. The asteroid 1999 JU3 has been selected for the target of the mission as a result of the whole known NEOs (Near-Earth Orbit Asteroids) survey. The resulting trajectory has 1.5 year asteroid proximity operation duration, and enables us to have four launch windows in between 2014 and 2015.
Based on these early phase studies, the detail trajectory has been designed utilizing an optimization technique. The trajectory plan includes one Earth swing-by in the Earth-to-Asteroid leg. Realistic constraints which reflect the spacecraft configuration, operational consideration and performance limit are taken into account.
This paper shows how the trajectory design activity contributes to the creation of the mission scenario for Hayabusa-2. The paper also describes the trajectory design technique and how the realistic constraints are incorporated into the trajectory optimization process.

Artist's image of Hayabusa-2 Spacecraft



Trajectory of Hayabusa-2
(Sun-Earth line fixed J2000EC cooridinates. Sun=(0,0), Earth=(1,0))