DETERMINATION OF GRAVITY AND DENSITY OF ASTEROID 25143 ITOKAWA BY LIGHT DETECTION AND RANGING INSTRUMENT ON HAYABUSA SPACECRAFT. S. Abe[1], T. Mukai[1], N. Hirata[1], O. S. Barnouin-Jha[2], A. Cheng[2], T. Mizuno[3], R. Nakamura[4], D. Scheeres[5], M. Yoshikawa[3], R. Gaskell[6], H. Demura[7], T. Hashimoto[3], T. Kubota[3], and M. Matsuoka[8], [1]Kobe University, 1-1 Rokkodai, Kobe, Hyogo 657-8501, JAPAN (avell@kobe-u.ac.jp), [2]APL, The Johns Hopkins University, [3]The Institute of Space and Astronautical Sciences, JAXA, JAPAN, [4]National Institute of Advanced Science and Technology, JAPAN, [5]University of Michigan, [6]Jet Propulsion Laboratory, CALTECH, [7]University of Aizu, JAPAN, [8]NEC Aerospace Systems, JAPAN.

Introduction:

The LIght Detection And Ranging instrument (LIDAR) onboard HAYABUSA spacecraft played a role of navigator as the laser altimeter, and also provided the scientific data of the shape of the target asteroid 25143 Itokawa, the surface topographical profiles and the internal structure resulting from the gravity estimation. In this paper, we will describe the mission specifications for the LIDAR instrument and the scientific results obtained by LIDAR.

Observations:

The LIDAR acted as a navigator, accompanying with the Optical Navigation Wide-Camera(ONC-W), when the HAYABUSA approached in the distance less than 50km from the asteroid Itokawa. LIAR started to operate and detected first returning signal from Itokawa's surface on 10th September 2005 at the distance of 48 km. The spacecraft was approaching step by step and after September 29th, the distance was less than 10 km. The HAYABUSA stayed in this Home Position (HP) for about 1 month where a nominal distance was between 3 and 11 km from the asteroid Itokawa along the line between the asteroid and the Sun. In the HP, a phase angle α defined as a Sun-asteroid-spacecraft angle, changed from 0 to about 30°. During November 2005, HAYABUSA spacecraft did the descent 5 times toward the touching-down to the asteroid Itokawa.

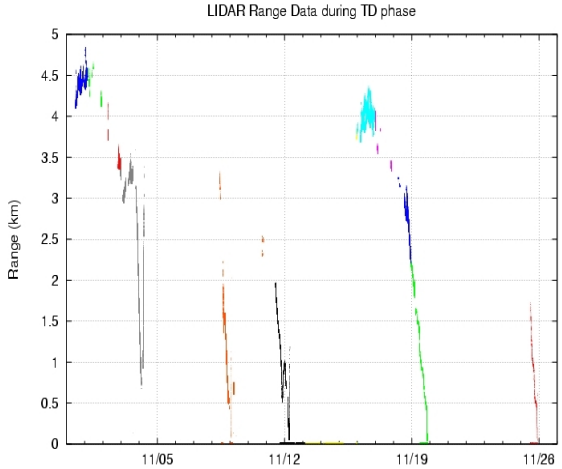

Figure. 1: LIDAR ranging during decent phase.

Analysis:

Because the asteroid Itokawa has not enough gravity to make the spacecraft around its orbit, it is important to estimate the accurate distance between the center of mass of Itokawa and spacecraft. However, the asteroid is so irregular object with 12.11 hour rotational period that it was hard to estimate the spacecraft position relative to the center of mass. In order to estimate the spacecraft position, we used LIDAR ranging and ONC-W navigation images with Itokawa's shape model. We should carefully analyze the data because the spacecraft had a lots of thrusters during decent. In this paper, we concentrate on the 12th decent data which was the best data for estimation of gravity parameters. We will discuss about density and macro-porosity of the asteroid Itokawa.

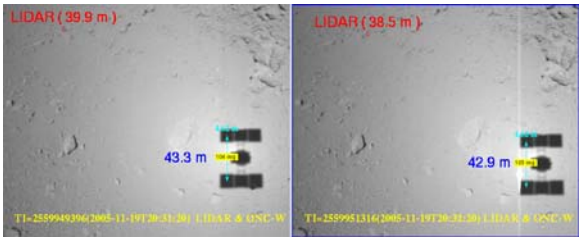

Figure 2 : In-flight confirmation of LIDAR ranging by using HAYABUSA's shadow.

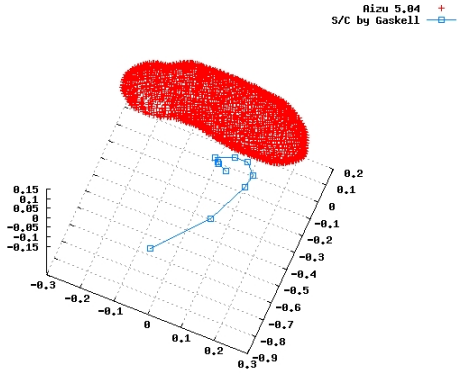

Figure 3 : Landmark tracking with LIDAR data.

References: [1] T. Mukai. et al. (2006) Advances in Space Research. [2] Demura, H. et al. (2006) this volume. [3] Gaskell R, (2005) AAS_05_289.