

VLBI OBSERVATION OF NARROW BANDWIDTH SIGNALS FROM THE SPACECRAFT

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The lunar gravity field has been investigated by Doppler measurement for the last 40 years. However, the gravity field of the rim of the Moon was not clearly investigated like the nearside. Over the rim of the Moon, the gravity force from the Moon acts mainly in the direction perpendicular to line of sight (LOS).

So we can't estimate the gravity field precisely only by Doppler measurements which is sensitive to the direction of LOS. In order to solve this problem, we apply very long baseline interferometry (VLBI) technique in VRAD (the differential VLBI radio sources) mission of Japanese lunar explorer SELENE (SELenological and ENgineering Explorer) in addition to a conventional 2-way and newly applied 4-way Doppler measurements. By measuring the difference of arriving time of the same wave front of a radio signal from the spacecraft (s/c) at two or more separated antennas, VLBI can precisely determine the position and the velocity of the s/c in the direction perpendicular to LOS.

Recently, the VLBI technique has been used for deep space missions of NASA and ESA. However, a large amount of VLBI data prevented the real time processing. Moreover, frequency allocation of the downlink signals was not appropriate for precise group delay measurement and limited the accuracy of angular component of the position of an s/c to several tens to nano radians (nrad). In order to detect a small motion of an s/c generated by the regional gravitational acceleration of the Moon, multi-frequency VLBI was proposed. When we measure the fringe phase with an accuracy of 10 degrees by using differential VLBI, the relative position of two sub-satellites around the moon will be decided with an accuracy of 20 cm for the 2000 km baseline.

In association with this plan, we have developed a low rate sampling and recording system for narrow bandwidth VLBI and correlation software. In order to confirm the performance and capability of our VLBI system, we conducted a VLBI observation of Japanese explorer GEOTAIL which transmitted a few carrier waves. In this paper, a detail of the VRAD system and the result of correlation and the group delay measurement would be shown.