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VLBI observations in VRAD mission of KAGUYA (SELENE)

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In VRAD mission of SELENE (KAGUYA), two VLBI radio sources are loaded on two sub-satellites called Rstar and Vstar. These on-board radio sources transmit four carrier wave signals to carry out differential VLBI observations between Rstar and Vstar. The signals consist of three carrier wave signals in S-band (fs1=2212 [MHz], fs2=2218 [MHz], and fs3=2287 [MHz]) and one in X-band (fx1=8456 [MHz]). The frequencies of these signals are allocated to resolve the cycle ambiguity of the differential phase delay of the X-band signal using the multi-frequency VLBI (MFV) method. When conditions of the MFV method are completely satisfied, the differential phase delay of the X-band signal can be estimated within an error of a few pico-seconds (ps).

In order to satisfy the conditions of the MFV method, most of error sources of the VLBI such as tropospheric delay and ionospheric delay must be compensated. For this purpose, we planned two kinds of differential VLBI observation methods. One is the switching VLBI observation method. By alternately observing two nearby spacecraft, some error sources of VLBI such as tropospheric fluctuation and ionospheric delay can be canceled. Another is the same beam VLBI observation method. When elongation between two lunar orbiting spacecraft becomes smaller than the beam width of the ground antenna (0.37 and 0.1 degrees for S-band and X-band signals), their signals can be simultaneously received. Most error sources are expected to be canceled out by applying this method. The same beam VLBI method is applied to differential phase delay estimation for the first time.

An initial check-out phase of the VRAD mission started from November 2007. We continue the VLBI observations from this period. As a result of the correlation for the data obtained in the initial checkout phase, the fringe phases can be derived successfully. Moreover, the differential phase delays (DPD) of the S-band signal can be derived without an cycle ambiguity in the period of the same beam VLBI observation. The error of DPD is smaller than 2 ps in 30 second integration. This result shows that the desired accuracy of the VRAD mission which is 3 ps in 110 second integration is achieved. Therefore, we confirmed the performance of the hardware and the software of the VRAD system. In the presentation, the brief overview of the same beam VLBI observation method and other VLBI observation method in VRAD mission of SELENE are shown. The results of the correlation and the delay estimation are also shown.