Precise spacecraft positions (5-10 nm) can be obtained with differential spacecraft-quasar VLBI (DVLBI) observations that directly measure the angular position of the spacecraft relative to nearby quasars. We performed more than 30 DVLBI experiments for the NOZOMI spacecraft navigation from September 2002 until June 2003. NOZOMI, which means “Hope” in Japanese, is the Japan's first Mars probe developed and launched by the Institute of Space and Astronautical Science (ISAS). NOZOMI was originally scheduled to reach its destination in October 1998, but an earlier Earth swingby failed to give it sufficient speed, forcing a drastic rescheduling of its flight plan. According to the new trajectory strategy, NOZOMI’s arrival at Mars is scheduled early in 2004 through two additional Earth swingbelts in December 2002 and June 2003.

Our main concern was to determine the NOZOMI orbit just before the second earth swingby on June 19, 2003. It was significantly important to get the timing to maneuver the NOZOMI before the swingby. ISAS scientists were afraid that the range and range rate (R&RR) orbit determination might not be available because it was difficult to point the high-gain antenna mounted the spacecraft toward the earth during the period between two swingby events. So we started to support the orbit determination of the NOZOMI using DVLBI technique since September 2002. These DVLBI experiments are also aimed to establish the positioning technology for the interplanetary spacecrafts in realtime.

We use nine VLBI antennas in Japan to carry out the DVLBI experiments at X-band. Algonquin 46-m of the Space Geodynamics Laboratory (SGL) of CRESTech also participated in the experiments. We equipped the state of the art “KS VLBI system” to these stations. The KS system is the multiple PC-based VLBI system equipped with a PCI-bus Versatile Scientific Sampling Processor (VSSP) board on the FreeBSD and Linux operating system. The KS system includes the original software packages which are data sampling and acquisition, realtime IP data transmission, and correlation analysis. For the purpose of analyzing the DVLBI observables we are developing the specific VLBI delay model for finite distance radio source. The model is already implemented in the DVBLI software package. The package will include the DVBLI observation scheduling to take account of the passage of the spacecraft near the quasar line of sight and the propagation delay estimating for the ionosphere and the neutral atmosphere.

We can successfully detect fringes of NOZOMI range signal for several baselines using software correlation in spite of weak and narrow-bandwidth signal. We provided 15 DVLBI group delay data sets to ISAS to support the orbit determination at the end of May 2003. On the other hand, ISAS scientists have fortunately succeeded to determine the NOZOMI orbit using R&RR observables at the end of May 2003. Preliminary results demonstrate that the DVBLI delay residuals are consistent with R&RR observables. However, the rms scatter between them are relatively large up to several tens nanoseconds. We are now evaluating our DVBLI data sets by comparing with the R&RR results.