Key Stone Project VLBI Stations (Kashima and Koganei)

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Abstract

The Key Stone Project VLBI Network used to consist of four VLBI stations at Kashima, Koganei, Miura, and Tateyama, but the 11-m antenna and other VLBI facilities at Miura and Tateyama stations have been transported to Tomakomai Experimental Forest of the Hokkaido University and to the campus of Gifu University, respectively. As a consequence, only two stations at Kashima and Koganei remained as IVS Network Stations. Regular VLBI sessions with the Key Stone Project VLBI Network continued until November 30, 2001, when the regular operations of the Key Stone Project VLBI Network were formally completed. The facilities at Kashima and at Koganei will be maintained and these systems along with the new sites at Tomakomai and Gifu will be used for the purposes of technical development and various observations in the future.

1. Introduction

The Key Stone Project (KSP) was a research and development project of the Communications Research Laboratory [1]. Four space geodetic sites around Tokyo were established with VLBI, SLR, and GPS observation facilities at each site. The locations of the four sites were chosen to surround Tokyo Metropolitan Area to regularly monitor the unusual deformation in the area (Figure 1). Therefore, the primary objective of the KSP VLBI system was to determine precise site positions of the VLBI stations as frequently and fast as possible. To realize this objective, various new technical advancements were attempted and achieved. By automating all of the process from the observations to the data analysis and by developing the real-time VLBI system using the high speed digital communication links, unattended continuous VLBI operations were made possible. Daily continuous VLBI observations without human operations were actually demonstrated and the results of data analysis were made available to the public users immediately after each VLBI session. Improvements in the measurement accuracies were also accomplished by utilizing fast slewing antennas and by developing higher data rate VLBI systems operating at 256 Mbps.

2. History

The construction of the KSP VLBI Network started in 1994 and the frequent regular VLBI sessions began in January 1995 with a single baseline between Kashima and Koganei VLBI stations. Since then, the other two stations at Miura and Tateyama were constructed and the six-baselines correlator system was developed. Miura and Tateyama stations began regular observations in December 1995 and in September 1996, respectively. The duration of each session was extended from about 5.5 hours to about 23.5 hours in July 1997 and the observation method was changed from tape-based VLBI to real-time VLBI at the same time. From that time until November 2001, the regular sessions were basically performed once every two days with a few exceptions when daily and almost continuous sessions were performed such as from Feb 28, 1999 until April 1, 1999 and from July 23, 2000 until November 11, 2000.

The KSP project had a predetermined term of five years at the time of its beginning and various challenging technical developments were necessary to realize its primary objective within the limited term. Since satisfactory accomplishments had been achieved, the project was planned

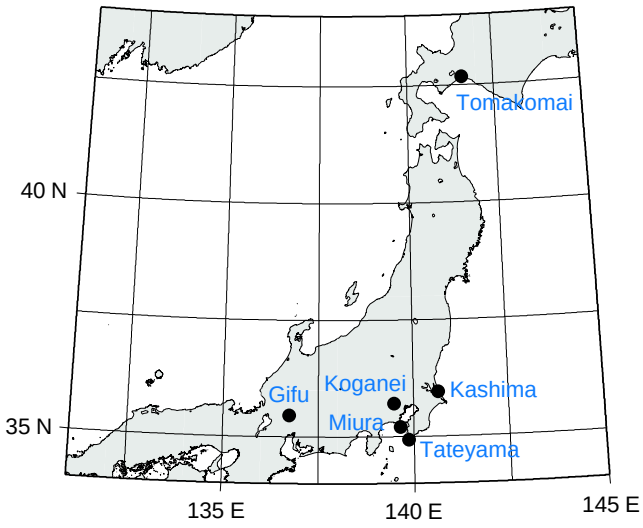

Figure 1. Geographic locations of four KSP VLBI stations and two new stations at Tomakomai and Gifu. 11-m antennas and other VLBI facilities at Miura and Tateyama have been transported to Tomakomai and Gifu, respectively.

to be completed by the end of September 2000. However, unusual site motions were detected for Tateyama and Miura stations from the end of June 2000 and it appeared that the data obtained with the KSP VLBI sessions were very useful to investigate the phenomena. Therefore, a lot of effort was made to continue the regular VLBI session with the KSP VLBI Network. Consequently, the operation of the Miura station was extended for about three months until the beginning of January 2001, and the operation of the Tateyama station was extended about one year until the end of November 2001. The site motions were the consequences of the crustal deformation around Izu Islands associated with the volcanic and seismic activities at Miyakejima Island and Kozushima Island. The data obtained with the KSP VLBI Network became the first experience for geodetic VLBI to continuously monitor in-situ dynamic crustal motion. It can be said that this event clearly demonstrated the capability and advantages of the automated VLBI system realized by the KSP VLBI Network.

The last VLBI session with the Miura station was carried out on January 4, 2001. The 11-m antenna and the observation facilities of the Miura station were transported to the Tomakomai Experimental Forest of the Hokkaido University after that. The antenna was reconstructed at the new site and the first successful VLBI observations were performed in November 2001. The 11-m antenna and the observation facilities of the Tateyama station were transported to the campus of Gifu University after the final regular KSP VLBI session on November 30, 2001. The antenna was reconstructed at the new site and the first successful VLBI observations were performed in June 2002. Pictures of these antennas are shown in Figure 2.

Figure 2. 11-m VLBI antennas at Tomakomai (Left) and Gifu (Right). These antennas and the VLBI observation facilities were transported from Miura and Tateyama KSP VLBI stations, respectively.

3. Activities in 2002

After two stations at Miura and Tateyama were transported to Tomakomai and Gifu, two other stations at Kashima and Koganei remained as IVS Network Stations. The facilities at Kashima and at Koganei were used for the purposes of technical development and five geodetic VLBI sessions. For technical developments, the baseline between Kashima and Koganei was used for the test bed for IP-based real-time VLBI observations and differential VLBI observations of spacecraft for precise orbit determination. For IP-based real-time VLBI observations, the high speed digital network link at Kasahima and Koganei was connected to the GEMnet research network of the NTT laboratories. For the spacecraft observations, Geotail and Nozomi spacecraft were observed with reference sources. In these observations, 64-m antenna at Usuda Deep Space Center of the Institute of Space and Astronautical Science, 34-m antenna at Kashima, 11-m antennas at Tomakomai and Gifu were used. The Nozomi spacecraft will arrive at Mars after the last flyby of the Earth. Before the flyby, the orbit of the spacecraft has to be determined very precisely to navigate the spacecraft with minimum consumption of fuel and the differential VLBI observations are expected to improve the orbit determination.

Five geodetic VLBI sessions conducted in 2002 are listed in Table 1. The purpose of the HOKT session is to determine precise position of the Tomakomai 11-m antenna. HOKT is the acronym of HOKkaido Telescope because Tomakomai station is located in Tomakomai, Hokkaido, Japan. The purpose of the CUTE sessions is to determine precise positions of the Tomakomai and Gifu 11-m antenna stations. CUTE is the acronym of the CRL and University Telescopes Experiment. The purpose of USUDA session is to determine precise position of the 64-m antenna at Usuda. All of these sessions have been processed by using the tape-based correlator system at Kashima.

4. Future Plans

Two K-5 systems have been assembled for test observations of the IP-based real-time VLBI observations using the Kashima (11-m) and Koganei (11-m) stations. The test observations will be performed on January 31, 2003. The Figure 3 shows the pictures of the K-5 VLBI observation

Table 1. Geodetic VLBI sessions conducted in 2002.

Session	Date	Participating stations
HOKT02	May 21	Kashima (11-m, 34-m), Koganei (11-m), Tomakomai (11-m)
CUTE01	June 19	Kashima (11-m), Tomakomai (11-m), Gifu (11-m)
CUTE02	November 11	Kashima (11-m), Tomakomai (11-m), Gifu (11-m)
USUDA1	December 7	Kashima (11-m), Koganei (11-m), Tomakomai (11-m), Gifu (11-m), Tsukuba (32-m)
CUTE03	December 16	Kashima (11-m), Tomakomai (11-m), Gifu (11-m)

system.

The 11-m antenna at Tomakomai will be upgraded to have 22 GHz receiver and the current S/X-band receiver will be removed. The CUTE sessions will be continued until the S/X-band receiver is removed from the 11-m antenna at Tomakomai. After the S/X-band receiver is removed, geodetic VLBI observations will be performed with Gifu (11-m), Kashima (11-m), and Koganei (11-m) stations. These stations will also be used for differential VLBI observations toward Nozomi spacecraft.

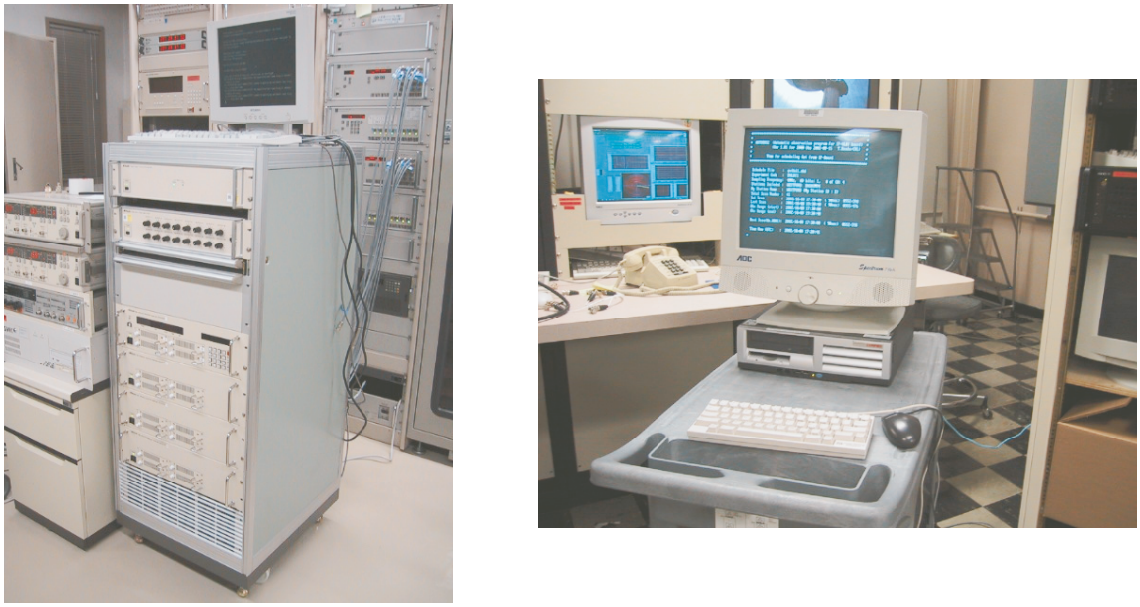

Figure 3. Full set of the K-5 VLBI observation system (Left) and 4-channel version for mobile observation (Right). The full set of the K-5 VLBI observation system consists of four PC systems with IP-VLBI board in each PC system.

References

[1] Special issue for the Key Stone Project, J. Commun. Res. Lab., Vol. 46, No. 1, March 1999