Kashima and Koganei 11-m VLBI Stations

Yasuhiro Koyama

Abstract

Two 11-m VLBI stations at Kashima and Koganei used to be a part of the Key Stone Project VLBI Network. The network consisted of four VLBI stations at Kashima, Koganei, Miura, and Tateyama. Since Miura and Tateyama stations have been transported to Tomakomai and Gifu, Kashima and Koganei 11-m stations are remaining as IVS Network Stations. After the regular VLBI sessions with the Key Stone Project VLBI Network terminated in 2001, these stations are mainly used for the purposes of technical developments and various observations. In the year 2003, three geodetic VLBI sessions were performed to evaluate the performance of the K5 and Gigabit VLBI systems. Many observations were also performed to determine precise orbit of the Nozomi and Hayabusa spacecrafts.

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.

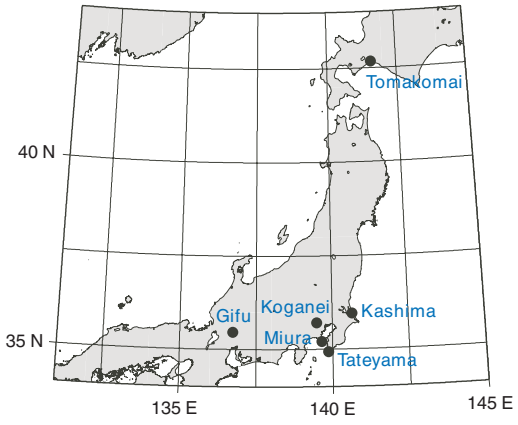

Figure 1. Geographic locations of four KSP VLBI stations and two stations at Tomakomai and Gifu.

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, two 11-m stations at Kashima and Koganei (Figure 2) are remaining as IVS Network Stations. After the regular VLBI sessions with the Key Stone Project VLBI Network terminated in 2001, 11-m VLBI stations at Kashima and Koganei are mainly used for the purposes of technical developments and various observations.

Figure 2. 11-m VLBI antennas at Kashima (Left) and Koganei (Right).

2. Activities in 2003

For technical developments, the baseline between Kashima and Koganei is now used as a test bed for IP-based real-time VLBI observations. Two stations used to be connected by high speed ATM (Asynchronous Transfer Mode) network with a collaboration with the NTT Laboratories until July 2003. The ATM connection was temporarily terminated and two stations are currently connected at the maximum speed of 100 Mbps. The network is shared by the usual traffic of the Communications Research Laboratory and is an ideal technical test-bed for e-VLBI under the shared network environment which will be inevitable in connecting most VLBI sites in the world.

Regarding the conventional geodetic VLBI experiment, four sessions listed in Table 1 were performed in 2003. The CUTE04 session was performed as a series of geodetic VLBI experiments to determine precise position of the Tomakomai and Gifu VLBI stations. CUTE is the acronym of the CRL and University Telescopes Experiment. The observations were made with the K4 VLBI system at the data rate of 256 Mbps. GEX011 session was performed to evaluate the Gigabit VLBI system and observations were conducted for only six hours with Kashima 11-m and Tomakomai 11-m stations. The other two VLBI experiments were performed by using three different VLBI systems. In the U03031 session, the K5 VLBI system and the Gigabit VLBI system were used at Kashima and Koganei 11-m VLBI stations in addition to the K4 VLBI system. The JD0306 session is one of the routine domestic VLBI sessions conducted by Geographical Survey Institute

(GSI). 11-m VLBI stations at Kashima, Tomakomai, Gifu and 32-m VLBI station at Yamaguchi participated in the session in addition to the three GSI VLBI stations at Tsukuba, Chichijima, and Aira. The K5 VLBI system was used at five stations, i.e. Kashima, Tsukuba, Tomakomai, Gifu, and Yamaguchi in addition to the K4 VLBI system except for the Yamaguchi station where only the K5 VLBI system was used. At Kashima and Tomakomai stations, the Giga-bit VLBI system was also used in parallel. The results from these two sessions were compared between different systems and the expected performance of the K5 VLBI system and the Giga-bit VLBI system were confirmed [2].

Table 1. Geodetic VLBI sessions conducted in 2003.

Session	Date	Participating stations
U03031	January 31	Kashima (11-m and 34-m), Koganei (11-m), Usuda (64-m), Gifu (11-m), Tsukuba (32-m)
CUTE04	March 12	Kashima (11-m), Tomakomai (11-m), Gifu (11-m)
GEX011	July 15	Kashima (11-m), Tomakomai (11-m)
JD0306	July 16	Kashima (11-m), Tomakomai (11-m), Yamaguchi (32-m) , Gifu (11-m), Tsukuba (32-m), Aira (11-m), Chichijima (11-m)

The two 11-m stations at Kashima and Koganei were also used for VLBI observations of the spacecrafts Nozomi and Hayabusa in 2003. Nozomi is the spacecraft of Japan Aerospace Exploration Agency (JAXA) launched in 1998 to explore the planet Mars, whereas Hayabusa is the spacecraft of JAXA launched in 2003 to explore the asteroid Itokawa. Since precise orbit determination of the spacecraft Nozomi was required before the final Earth swing-by in June 2003, VLBI observations of the spacecraft Nozomi were carried. Many VLBI stations in Japan including the 11-m VLBI stations at Kashima and Koganei, and the VLBI station at Algonquin participated in the observations. In total, 34 VLBI sessions were performed in 2003. The spacecraft Hayabusa is expected to arrive at the asteroid Itokawa in 2005 and precise orbit determination of the spacecraft will be essential to make the mission successful. In 2003, several observations were made mainly to survey adequate celestial radio sources for differential VLBI observations to be used in the critical observations which will be performed in 2004 and 2005.

3. Staff Members

The 11-m antenna stations at Kashima and Koganei are operated and maintained by the Radio Astronomy Applications Group at Kashima Space Research Center, Communications Research Laboratory. The staff members of the group is listed in Table 2. The operations and maintenance of the 11-m VLBI station at Koganei is also greatly supported by the Optical Space Communications Group at Koganei Headquarters of CRL. We are especially thankful to Dr. Hitoshi Kiuchi and Dr. Yoshinori Arimoto for their supports.

4. Future Plans

The current network connection between Kashima and Koganei is limited to the maximum speed of 100 Mbps, but the speed will be upgraded to 10 Gbps in April 2004. The connection

Table 2. Staff members of Radio Astronomy Applications Group, KSRC, CRL

Name	Main Responsibilities
Tetsuto KONDO	Group Leader
Eiji KAWAI	Antenna System
Yasuhiro KOYAMA	International e-VLBI
Ryuichi ICHIKAWA	Spacecraft Orbit Determination
Junichi NAKAJIMA	High Data Rate VLBI System
Mamoru SEKIDO	Spacecraft Orbit Determination
Hiro OSAKI	International e-VLBI
Hiroshi TAKEUCHI	Antenna System
Moritaka KIMURA	High Data Rate VLBI System
Hiromitsu KUBOKI	Antenna System

from Koganei to the TransPAC was upgraded to 1 Gbps in 2003. We are planning to perform e-VLBI observations under the collaborations with the Haystack Observatory by using the improved network connections.

The S/X receivers of the 11-m antenna at Tomakomai was removed to install the new 22 GHz receiver to the antenna system. As the results, CUTE sessions will only be performed with three VLBI stations at Kashima, Koganei, and Gifu. Instead, 22 GHz VLBI observations will be made with Kashima 34-m VLBI station and the Tomakomai 11-m VLBI station after the new 22 GHz receiver is installed to the Tomakomai station.

In 2004, we are planning to continue VLBI observations toward the spacecraft Hayabusa for its precise orbit determination. The use of phase delay measurements will be investigated to improve the accuracy and precision of the determination of the orbit.

Currently, the antenna system and the VLBI facilities are controlled by the automated VLBI observation system developed for the Key Stone Project. Since the system is running on the relatively old Unix operating system and we are planning to use FS9 in the future. As of January 2004, we have succeeded to control the antenna system from the FS9 software and we expect we can use the FS9 software for VLBI sessions at two 11-m VLBI stations at Kashima and Koganei in the future.

In April 2004, Communications Research Laboratory will be integrated with the Telecommunications Advanced Organization of Japan (TAO) and the new institute will be established. The name of the institute will be National Institute of Information and Communications Technology and the VLBI activities in the CRL will be continued under the new institute.

References

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

[2] Koyama, Y., T. Kondo, H. Osaki, K. Takashima, K. Sorai, H. Takaba, and K. Fujisawa, IVS CRL TDC News, No. 23, Nov. 2003, pp. 26-30