Kashima and Koganei 11-m VLBI Stations

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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. Since 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 2004, flux monitoring observations of binary black hole candidates were initiated in collaboration with Gifu University by using the Gifu-Kashim11 baseline. Many observations were also performed to determine precise orbit of the spacecraft Hayabusa.

1. Introduction

The Key Stone Project (KSP) was a research and development project of the National Institute of Information and Communications Technology (NICT, formerly 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).

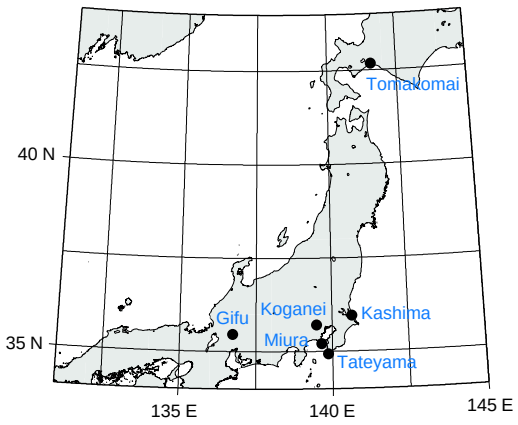

Figure 1. Geographic locations of four KSP VLBI stations and two stations at Tomakomai and Gifu.

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 processes 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.

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. Since regular VLBI sessions with the Key Stone Project VLBI network terminated in 2001, the 11-m VLBI stations at Kashima and Koganei are mainly used for the purposes of technical developments and other observations.

Figure 2. 11-m VLBI antennas at Kashima (left) and Koganei (right).

2. Activities in 2004

For technical developments, the baseline between Kashima and Koganei is now used as a test bed for real-time VLBI observations based on the Internet Protocol (IP). Two stations used to be connected by high speed Asynchronous Transfer Mode (ATM) network in collaboration with the NTT Laboratories until July 2003. In April 2004, NICT started to operate the high speed research test-bed network called JGNII and both the Kashima and Koganei stations are connected to the JGNII backbone with OC-192 (10 Gbps) connection. JGNII is a follow-on project of the JGN (Japan Gigabit Network) which was operated by the Telecommunications Advancement Organization of Japan (TAO) for 5 years from 1999. Since the TAO was merged with Communications Research Laboratory to establish the NICT as a new institute, JGNII succeeded the JGN project. Whereas the JGN project was operated based on the ATM architecture, the new JGNII network uses mainly IP. One GbE (Gigabit Ethernet) interface is installed at Koganei station and two GbE interfaces are connected at Kashima station. This environment provides an ideal opportunity for e-VLBI research and developments.

The operating software of the antenna and VLBI observing system at Kashima 11-m station was updated from the Key Stone Project field system to the FS9 field system. Since the antenna

control units of the Kashima and Koganei 11-m stations are identical to the old 26-m station at Kashima, the FS9 field system which was used at the 26-m station was copied and made available. Currently both the old field system and FS9 are available at the Kashima 11-m station and we are planning to install FS9 also at the Koganei 11-m station.

In the year 2004, flux monitoring observations of binary black hole candidates were initiated with the baseline between Gifu (11-m) and Kashima (11-m) stations. This project is a joint effort of NICT and Gifu University. The purpose of the project is to monitor the flux density of black hole binary candidate sources by means of VLBI to detect flux density variation due to the orbital motion of the binary system. For this purpose, K5/VSSP systems are used at both stations and the data are correlated by the K5 software correlator program. Many observations were also performed to determine precise orbit of the spacecraft Hayabusa. The spacecraft was launched by Japan Aerospace Exploration Agency on May 9, 2003 to approach the asteroid Itokawa. The X-band telemetry signal from the spacecraft is used to demonstrate precise orbit determination by means of differential VLBI observations. Since precise orbit determination of the spacecraft Hayabusa is required to efficiently navigate the spacecraft to approach the asteroid Itokawa, many VLBI stations in Japan including the 11-m VLBI stations at Kashima and Koganei participated in the observations. 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 2004, 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 2005.

In addition, two sessions listed in Table 1 were performed in 2004. The tsrt04 session is a real-time e-VLBI demonstration session with four VLBI sites at Kashima (11-m), Westford (18-m), Onsala (20-m), and GGAO (5-m). All stations are connected to the high speed research Internet and the real-time data transfer of observed data was challenged. The tec04259 session was performed to obtain Total Electron Content (TEC) data by means of VLBI. The purpose of the session is to compare the TEC results from the VLBI session with the TEC value evaluated from the global ionospheric model.

Table 1. R&D VLBI sessions conducted in 2004.

Session	Date	Participating stations
tsrt04	August 30	Kashima (11-m), Westford (18-m), Onsala (20-m), GGAO (5-m)
tec04259	September 15	Kashima (11-m), Mizusawa (20-m), Gifu (11-m)

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, NICT. The staff members of the group are 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 and Quasi-Zenith Satellite System Group at Koganei Headquarters of NICT. We are especially thankful to Jun Amagai and Futaba Katsuo for their support.

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

Name	Main Responsibilities
Tetsuro KONDO	Group Leader
Eiji KAWAI	Antenna System
Yasuhiro KOYAMA	International e-VLBI
Ryuichi ICHIKAWA	Spacecraft Orbit Determination
Junichi NAKAJIMA	VLBI System Developments
Mamoru SEKIDO	Spacecraft Orbit Determination
Hiroshi TAKEUCHI	VLBI System Developments
Moritaka KIMURA	VLBI System Developments
Hiromitsu KUBOKI	Antenna System
Thomas HOBIGER	Visiting Researcher
Eric VIDAL	Visiting Researcher
Jose ISHITSUKA	Visiting Researcher

4. Future Plans

The S/X receivers of the 11-m antenna at Tomakomai was removed and will be replaced by a new 22 GHz receiver. As a result, CUTE sessions will only be performed with three VLBI stations at Kashima, Koganei, and Gifu. 22 GHz VLBI observations, on the other hand, will be made with the Kashima 34-m VLBI station and the Tomakomai 11-m VLBI station once the new 22 GHz receiver is installed at the Tomakomai station.

In 2005, 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.

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