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. 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 2005, a test geodetic VLBI experiment using the multi-channel gigi-bit AD sampler unit ADS2000 was performed between Kashima and Koganei 11m VLBI stations. 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).

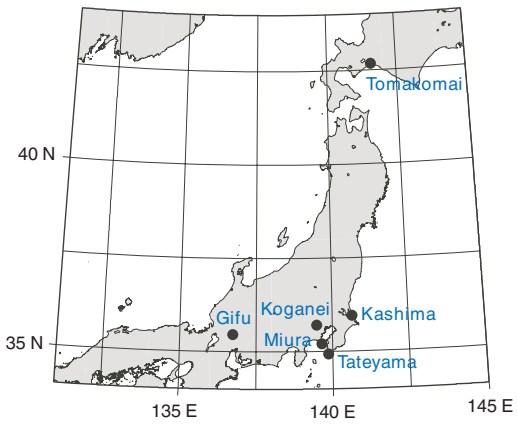

Figure 1. Geographic locations of four KSP VLBI stations and two stations at Tomakomai and Gifu.

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 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.

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 2005

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). The two stations used to be connected by high speed Asynchronous Transfer Mode (ATM) network with a collaboration with the NTT Laboratories until July 2003. From April 2004, NICT started to operate 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 was started to succeed the JGN project. Whereas the JGN project was operated based on the ATM architecture, IP is mainly used on the new JGNII network. One GbE (Gigabit Ethernet) interface is installed at Koganei station and two GbE interfaces are connected at Kashima station. This environment is providing us an ideal opportunity for e-VLBI research and developments.

The use of old operating software of the antenna and VLBI observing system at Kashima 11-m station was terminated and the newly installed fs9 software in 2004 now became the main operating

software of the station. Currently, the fs9 operating system is being copied to a new PC system to use it as the replacement for the Koganei 11-m VLBI station as the main operating software.

In the year 2005, a test geodetic VLBI experiment was performed on March 11 and 12 for 24 hours by using the newly developed multi-channel giga-bit sampler units called ADS2000 [1]. By using the ADS2000 and the K5/VSI system, the 16 channels of data (10 for X-band and 6 for S-band) were recorded to the hard disks in the K5 system at the total data rate of 1024Mbps. Each channel was sampled at the sampling rate of 32Msps and the digitization level of 2 bits/sample. The observed data were processed by the K5 software correlator and then analyzed by the SOLVE/CALC software. From this experiment, the baseline length was estimated with the RMS uncertainty of 1.3 mm and the performance of the system was confirmed.

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 was used to demonstrate precise orbit determination by means of differential VLBI observations. Since precise orbit determination of the spacecraft Hayabusa was 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 approached the asteroid Itokawa in September 2005 and precise orbit determination of the spacecraft was performed before and after the arrival of the spacecraft to the asteroid.

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 is listed in Table 1. 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, Futaba Katsuo for their supports.

Table 1. Staff members of Radio Astronomy Applications Group, KSRC, NICT

Name	Main Responsibilities
Tetsuro KONDO	Research Center Supervisor / Software Correlator
Yasuhiro KOYAMA	Group Leader / International e-VLBI
Eiji KAWAI	Antenna system
Ryuichi ICHIKAWA	Spacecraft VLBI
Junichi NAKAJIMA	VLBI System Developments
Mamoru SEKIDO	Spacecraft VLBI
Hiroshi TAKEUCHI	VLBI System Developments
Moritaka KIMURA	VLBI System Developments
Hiromitsu KUBOKI	Antenna System
Masanori TSUTSUMI	System Engineer
Atsutoshi ISHII	Developments for Small Antenna System

4. Future Plans

In 2006, we are planning to continue VLBI observations toward the spacecraft Hayabusa and Geotail 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. We will also continue to install new fs9 operating software at the Koganei 11-m VLBI station. It is also planned to increase the network speed of ATM connection between Kashima and Koganei from its current speed of 2.4Gbps to 4.8Gbps by using two connections for domestic e-VLBI observations in addition to the current IP network connection between two sites (two 1Gbps links).

References

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