Tsukuba 32-m VLBI Station

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Abstract

This report summarizes the specification of our VLBI systems and the members of the Geographical Survey Institute (GSI) VLBI section. We present our history of VLBI activities and the status. Firstly, GSI developed three mobile VLBI systems and had repeated observations with CRL. On the other hand, as GSI installed 1000 permanent GPS stations all over Japan (GEONET), our VLBI strategy has been shifted from domestic mobile experiments to permanent stations and international experiments. Last year GSI constructed a domestic VLBI network with five permanent stations. A main station of our network is Tsukuba 32-m VLBI station (Fig 1). The station also becomes a key station in the international VLBI networks.

1. GSI VLBI site

Our purposes of VLBI activities are the following.

1. Constructing a new geodetic reference frame referred to ITRF94.
2. Simultaneous and continuous monitoring of relative movement of the plates surrounding Japan.
3. Contribution to global environmental preservation and investigations into the geophysical phenomena by joining the International Geodetic VLBI Network.
4. Establishment of a terrestrial reference frame to improve the accuracy of positioning by space geodetic survey techniques.

GSI operates the domestic VLBI network with five stations (Shintotsukawa, Kashima, Tsukuba, Chichijima, Aira) in order to achieve these purposes. GSI also operates 959 GPS stations (GEONET: GPS Earth Observation Network). To connect both networks we carried out a colocation survey by GPS and by total station at each VLBI station. The measured precision was ± 5 mm for horizontal component and ± 2 cm for vertical component. We have a plan of colocation between VLBI and GPS network aiming at the higher precision (± 1 mm).

2. Specification of GSI VLBI systems

GSI has a domestic VLBI network with five stations. The recording system of the network is K4 system. The specification of GSI's five VLBI systems are presented in Table 1.

Diameters of the antennas are 26 m (Kashima), 3.8 m (Shintotsukawa) and 10 m (Chichijima and Aira). Antenna mount type is non-shifted AZ-EL mount. Receivers are designed for S-band and X-band. Recording system is K4 developed by Communications Research Laboratory (CRL). Recording rate was 64 Mbps. The recorded tape was processed with K4 correlator at Tsukuba VLBI Center.

Figure 1. Tsukuba 32m VLBI antenna.

Table 1. Technical parameters of the radio telescopes of GSI.

Parameter	Tsukuba	Kashima	Chichijima	Aira	Shintotsukawa
year of construction	1998	1968	1997	1997	1995
radio telescope	cassegrain	cassegrain	cassegrain	cassegrain	cassegrain
(S-band)			prime forcus	prime forcus	prime forcus
Mount	Az-El	Az-El	Az-El	Az-El	Az-El
diameter of main ref.	$32m$	$26m$	$10.26m$	$10.26m$	$3.8m$
surface contour of ref.	$\pm 0.5mm$		$\pm 0.5mm$	$\pm 0.5mm$	$\pm 0.5mm$
azimuth velocity	$3°/s$	$1°/s$	$3°/s$	$3°/s$	$2.9°/s$
elevation velocity	$3°/s$	$1°/s$	$3°/s$	$3°/s$	$1°/s$
X-band GHz	$7.78 - 8.98$	$8.05 - 8.55$	$7.78 - 8.98$	$7.78 - 8.98$	$8.18 - 8.98$
S-band GHz	$2.12 - 2.52$	$2.20 - 2.40$	$2.12 - 2.52$	$2.12 - 2.52$	$2.21 - 2.45$
Recorder	Mark IV, K4	VLBA, K4	K4	K4	K4
Controller	FS9, GAOS	FS9, GAOS	GAOS	GAOS	GAOS

3. Technical Staff of the VLBI group at GSI

Table 2 lists the VLBI staff at GSI.

4. History of VLBI at GSI

The first system was a mobile system with a 5-m diameter antenna. In 1984, GSI had the first VLBI experiment with Kashima VLBI station of Communications Research Laboratory. Since 1986, GSI participated in a project named "VLBI Experiment for Geodetic Application" (VEGA)

Table 2. Staff working at GSI VLBI section.

Name	Position	Jobs
Shigeru MATSUZAKA	IVS Networks Representative	
Misao ISHIHARA	VLBI leader	
Keizo NEMOTO	Colocation chief	Colocation, H-maser, Operation
Masao IWATA	Correlation chief	Correlation, Operation
Kousei SHIBA	Operation chief	Experiments Coordination, Operation
Kazuhiro TAKASHIMA	Analysis chief	Baseline Analysis, Operation
Shinobu KURIHARA	Operator	Baseline Analysis, Operation
Michiko ONOGAKI	Operator	Antenna maint., Operation
Kyoko KOBAYASHI	Assistant	Correlation, Operation

using the mobile system. The purposes of the VEGA project were the detection of crustal deformation, accuracy improvement of the Japanese precise geodetic network, and contribution to determination of GPS satellite orbits.

From 1986 to 1994, GSI repeated mobile VLBI experiments at eight sites in Japan. By comparing with the survey results in 1987 and 1989, GSI succeeded in detecting a velocity of the Philippine plate relative to Kashima of 3.7 cm per year. This plate motion is asserted to be the main force of earthquakes in the Tokai area. The main station of these mobile VLBI experiments was Kashima station (26 m). GSI developed three mobile systems. Diameters of these antennas were 5 m, 2.4 m (with CRL) and 3.8 m. In 1992, the ownership of Kashima VLBI station (26 m) was transferred from CRL to GSI. In 1992, GSI started international VLBI experiments participating in the DOSE project with Kashima VLBI station.

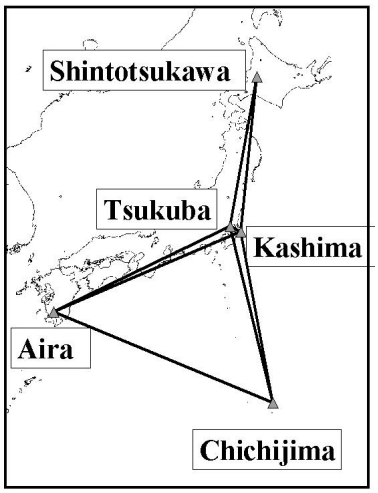

Figure 2. GSI domestic VLBI network.

Distributions of these stations are shown in Fig. 2. Baseline lengths between each station are about 1000 km. Shintotsukawa and Kashima are on the North American plate, Chichijima

is on the Philippine Sea Plate, Aira is on the Eurasian plate. Baseline analysis was done with CALC/SOLVE. After February 1997, GSI had periodical (seasonal) experiments. Standard deviations of baseline length are 6 mm with Shintotsukawa and 4 mm with others in each experiment.

5. Outlook

GSI finished constructing Tsukuba VLBI station (32 m) on 26th March 1998 and had the first (official) experiment in June 1998. We introduced some ideas to guarantee the high performance of Tsukuba VLBI antenna. The back panels and ventilation system keeps the shape of the antenna surface from deforming caused by temperature change. The antenna structure is covered with sunshade panels. GPS antenna is settled on the top of the VLBI antenna for colocation. Helium cooling system is installed for X band receiver. The front-end and back-end are connected with optical transmission devices to improve the SNR. Back-end room is shielded from radio noise and H-maser room is shielded from electromagnetic noise. Mark IV and K4 type recording are available. GSI also is developing a dubbing machine from K4 to Mark IV. IGS station (TSKB) is close by the 32 m antenna (300 m). Colocation at Tsukuba will be achieved at mm-level.

References

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