Kashima 11 m and Koganei 11 m VLBI Stations
Report for 2017-2018

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Abstract The Kashima 11 m and Koganei 11 m stations have been participating R1, T2, CRF, APSG, and AOV sessions conducted by the IVS and AOV. In addition to these regular sessions, Kashima 11m antenna has participated CONT17. In recent years, S-band receiver of Koganei 11m station is suffered from radio frequency interference, and we found sensitivity degradation. Kashima and Koganei sites are designated as a member of GGOS Space Geodetic Network. Collocation is important subject for GGOS, thus local survey information on collocation among VLBI 11m antenna, GPS, and SLR reference points in 1996-1999 and additional survey conducted in 2013 are briefly described for reminding.

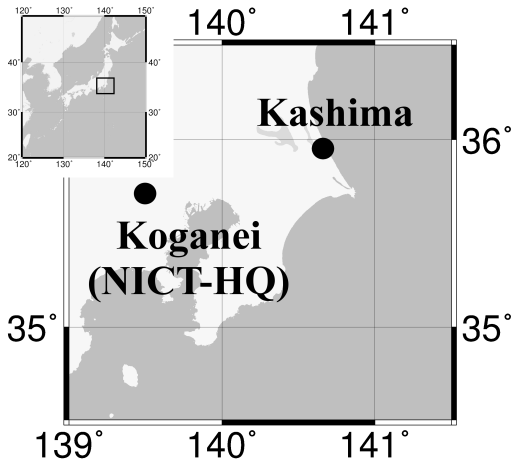

Fig. 1 Location of NICT-Koganei Headquarters and Kashima.

1 General Information

A pair of 11 m diameter antennas have been operated by the VLBI group of the Space-Time Standard Laboratory (STSL) of the National Institute of Information and Communications Technology (NICT). The Kashima 11 m antenna is located at Kashima Space Technology Center (KSTC), on the east coast of the Japanese main island. The 11 m antenna is in the same campus with the Kashima 34m diameter radio telescope[1] at 240 m distance. The Koganei 11 m diameter antenna is located at the headquarters of the NICT in Koganei Tokyo (Figure 1). These 11 m VLBI antennas at Kashima and Koganei (Figure 2) were built together with two other VLBI stations for Key Stone Project (hereafter referred as KSP). The aim of the KSP[2] was monitoring of crustal deformation around the Tokyo metropolitan area by using multiple space geodetic techniques; VLBI, GPS, and SLR. That project was operated in the period between 1995 and 2001. After the KSP project has terminated in 2001, two other 11m diameter antennas were transferred to Gifu Univ. and Hokkaido Univ., respectively, for astronomical research and education. Kashima and Koganei 11 m stations remained in NICT and they have been used for technology developments and geodetic observations. Participations to the IVS sessions of these two stations by regular basis have started after the “Great East Japan Earthquake” occurred in March 2011. Post-Seismic Deformation (PSD) models for Kashima11m and Koganei are included in ITRF2014.

NICT Space-Time Standards Laboratory/Kashima Space Technology Center

NICT KSP Network Station

Fig. 2 11 m VLBI antennas at Kashima (left panel) and Koganei (right panel).

2 Component Description

2.1 Kashima 11m Antenna

The antenna parameters of Kashima-11 and Koganei-11 are summarized in Table 1. Receiving frequency bands are S and X bands, and room temperature LNAs are used. Then signal is converted to three intermediate frequency (IF) signals, which has frequency range of 500-1000MHz. X-band signal is divided in to two IFs, which is XL for 7.7-8.2 GHz, and XH for 8.1-8.6GHz.

Band-pass filters for S-band (2212-2360 MHz) were additionally installed in 2010 at both stations for mitigation of radio frequency interference (RFI) from cell phone stations.

The local oscillator (LO) frequency for XH at the Kashima 11 m station has been changed from 7600 MHz to 7680 MHz since 2008, so that observing frequency range to be changed from 8100-8600 MHz to 8180-8680 MHz.

2.2 Koganei 11m Antenna

Kashima and Koganei 11m stations have been participating to IVS session with frequency about once in a month. In recent years, we have received a series of warning from IVS correlator report that S-band fringe detection rate is getting lower at Koganei 11m station.

Table 1 The antenna parameters of the 11 m antennas.

		Kashima	Koganei
Antenna Type		Cassegrain type	
Diameter		11 m	
Mount Style		Az El mount	
Latitude		N 35° 57' 19.46"	N 35° 42' 37".89
Longitude		E 140° 39' 26.86"	E 139° 29' 17".06
Altitude		62.4 m	125.4 m
Rx Freq. [MHz]	S band	2212 ∼ 2360	2212 ∼ 2360
	X Low band	7700 ∼ 8200	7700 ∼ 8200
	X High band	8180 ∼ 8680	8100 ∼ 8600
Local Freq. [MHz]	S band	3000	3000
	X Low band	7200	7200
	X High band	7680	7600
SEFD [Jy]	X-band	5700	9500
	S-band	3300	5500

Cause of the issue was clearly recognized by monitoring of the first low noise amplifier (LNA) output. In Feb. 2018, we checked S-band LNA output of Koganei 11m station for all the azimuthal antenna direction by 30 degrees steps with the elevation angle at 5 degrees. Strong RFI at 2.1 GHz and 2.6 GHz (hereafter referred as f_1, and f_2 for these frequencies) were received at +3dBm as peak level. Higher order inter-modulation of these two frequencies ($f_2 - f_1, f_1 + f_2, 2f_2 - f_1, 2_f 2 - f_1, 2f_1 + f_2, 2f_2 + f_1$) were detected for the most of all directions, and they were stronger in direction of Az=270 ∼ 360. These data indicate that LNA gain is saturated by the RFI. Figure 3 shows the radio fre-

quency spectrum of the LNA output obtained by Max-hold measurement for 30 sec with 3MHz resolution bandwidth. Bandwidth of the RFI signal was about 60MHz. From these measurement data, power levels of each RFI (f_1, f_2) are estimated around +16dBm. Receiver system of the KSP 11m station is composed of S/X-band dual frequency waveguide system equipped with high gain (50dB) waveguide type room temperature LNA. Then input power level to the LNA is estimated to be no less than -34dBm per signal. Possible counter measure to this problem will be replacement of receiver system by cooled LNA with superconductor filter in front of it, however it is not allowed due to budgetary condition.

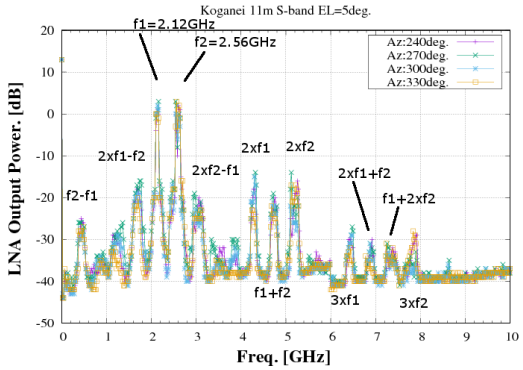

Fig. 3 Frequency spectrum of receiving power at the S-band first LNA output of Koganei 11m station. Antenna was pointing to west direction with elevation angle at 5 degrees. Measurement was made by Maxhold for 30 seconds with 3 MHz resolution bandwidth. Higher order harmonics and inter-moderation of two strong RFI at 2.1 GHz (f_1) and 2.6 GHz (f_2) indicates saturation of the first LNA.

2.3 Data Acquisition Systems

The K5/VSSP32 [3] has four channels of video band signal input per unit. Four units of K5/VSSP32 constitute one geodetic VLBI terminal with 16 video channels. This system is constantly used for geodetic VLBI observations including IVS sessions. This K5/VSSP32 sampler has digital filter functionality inside. The input video signal is digitized with 8-bit quantization with 64 MHz sampling. Then the signal is shaped for recording bandwidth by digital filter, the data come out from USB 2.0 interface at the data-rate corresponding to the observation mode. The data stream is recorded on a standard Linux file system in K5/VSSP32 format[1]. Data format conversion from K5/VSSP32 to Mark IV, VLBA, and Mark-5B are available with conversion tools[2].

Table 2 VLBI data sampler/DAS systems equipped at the Kashima 11 m and Koganei 11 m stations.

System	K5/VSSP32 (4 units)	ADS3000+(K5/VSI)
Video Converter	K4/KSP 16ch	not necessary
# of Input Channels	4 /unit x 4 units	1 or 2
# of Output Channels	16	1, 2, 16
Input Freq. Range	0 - 300 MHz	0 - 2 GHz
Sampling Rate [Msps]	0.04,0.1,0.2,0.5,1, 2,4,8,16,32,64	128, 256, 1024, 2048,4096
Quantization bit	1,2,4,8 bit	
Max. data rate [Mbps]	256/unit x 4	4096
Output Interface	USB 2.0	VSI-H

Another sampler ADS3000+[4, 5] and PC-VSI data recording system are available at Koganei station (Table 2), however, Geodetic VLBI observation has been mostly made by using K5/VSSP32. The ADS3000+ is used only at Kashima 34m station[1], but not used at 11m stations yet.

2.4 Network for e-Transfer

VLBI observation data recorded in the K5/VSSP32 format is converted to Mark5B before submission to correlation center if necessary. All the VLBI data in NICT are transported to correlation centers by e-transfer from data server at Kashima. Network connection at 10 Gbps is provided by the High Speed R&D Network Testbed JGN. All the VLBI station of NICT (Kashima 11 m, Koganei 11 m, and The Kashima 34 m) shares the same 10 Gbps network. Figure 5 shows schematic diagram of local network connection and outbound network.

[1] Please see `http://www2.nict.go.jp/sts/stmg/K5/VSSP/vssp32_format.pdf`

[2] Observation and data conversion software for K5/VSSP are freely available from `http://www2.nict.go.jp/sts/stmg/K5/VSSP/index-e.html`

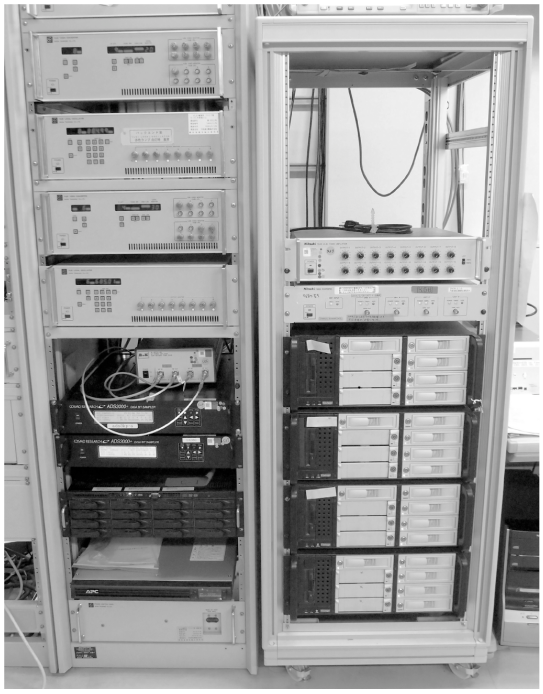

Fig. 4 Data acquisition terminal (K5/VSSP and K5/VSI).

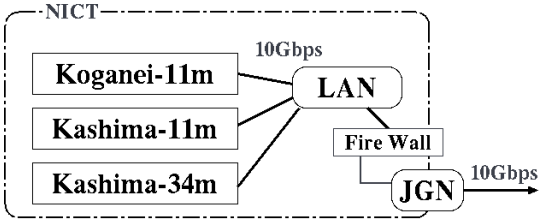

Fig. 5 Network environment of VLBI station in NICT (Kashima 11 m, Kashima 34 m, and Koganei 11 m). Nominal network speed is 10 Gbps. Practically available data transfer rate is 5 Gbps at maximum.

2.5 GNSS Station and Collocation of VLBI, SLR, and GPS

GPS receivers had been installed at Kashima and Koganei sites in the Key Stone Project. Currently, GNSS stations 'KSMV00JPN' at Kashima (Fig. 6) and 'KGNI00JPN' at Koganei are operated in the observation network of International GNSS Service (IGS). Their observation data is routinely submitted to the IGS Data Center. Importance of the local tie of the different space geodetic techniques has been recognized in the KSP. Local survey to link SLR, VLBI and GPS stations have been conducted in the project for the period 1996-1999. Measurement precision of 1.5 mm standard deviation and detail of the local survey are summarized by Hasegawa et al.[6] In addition, another local survey was conducted only for Koganei site in 2013. This survey was triggered by installation of new 1.5m optical telescope, which is for optical satellite communication experiment of other project. The local survey data of Kashima and Koganei site are available from the KSP homepage [3] 'Survey' `http://ksp.nict.go.jp/survey/contents.htm` and 'Supplement' `http://ksp.nict.go.jp/survey/Supplment/KSP-colloc.html`.

Fig. 6 The Kashima 11 m antenna and GNSS receiver pillar of the IGS tracking station KSMV.

3 Staff

Following staffs (alphabetical order) are contributing to run Kashima 11 m and Koganei 11m stations.

Hasegawa Shingo: Supporting staff for IVS observation, operation of data conversion and maintenance of file servers for e-transfer.

Ichikawa Ryuichi: In charge of GNSS station.

Kawai Eiji: In charge of maintenance of Kashima 11m and Koganei 11m station.

Kondo Tetsuro: Maintaining K5/VSSP software package, which is used for data acquisition and conversion from K5 to Mk5B data.

Miyauchi Yuka: In charge of data acquisition software.

[3] `http://ksp.nict.go.jp/`

Sekido Mamoru: In charge of observation operation and overall activities of the Kashima and Koganei VLBI stations.

Tsutsumi Masanori: In charge of network security and maintenance of computers used in the project.

4 Current Status and Activities during the Past Year

The Kashima and the Koganei 11 m stations are participating in geodetic VLBI sessions IVS-T2, APSG, CRF. and AOV sessions. Kashima 11m participated to Cont17 session.

Degradation of S-band receiver sensitivity due to RFI at Koganei 11m antenna is a serious issue. Although there is no plan of counter measure yet. The Koganei 11 m antenna has been operated by time sharing with the Space Environment Laboratory (SPEL). When the antenna is free from VLBI observation, its X-band receiver is used for receiving down-link signal from the STEREO satellite [4] by the SPEL.

Confirmation of antenna pointing has been made before every session, and no significant error has been reported. Last update of antenna pointing model was 36 doy 2017 and 11 doy 2015 for Kashima 11m and Koganei 11m, respectively.

Acknowledgements

We thank the High Speed R&D Network Testbed JGN and the Information System Section of NICT for supporting the high-speed network environment.

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