Kashima 11-m and Koganei 11-m VLBI Stations

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Abstract The Kashima 11-m and Koganei 11-m stations have participated in R1, T2, CRF, APSG, and AOV sessions conducted by the IVS and Asia-Oceania VLBI Group for Geodesy and Astrometry (AOV)[1]. Unfortunately, serious degradation of performance was found with the Kashima 11-m antenna in July 2019. After this, the Kashima 11-m station could not return back to normal operation. Following the decision to shut down the Kashima VLBI site, Kashima 11-m antenna was dismantled in 2020. Co-location local surveys were performed for four sites of KSP (Kashima, Koganei, Miura, and Tateyama) in 1996–1999 and for the Koganei site in 2013. This local tie information was submitted to the ITRF2020 Combination Center.

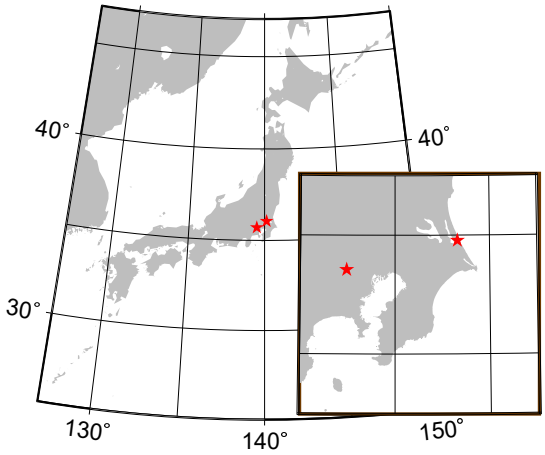

Fig. 1 Location of NICT-Koganei Headquarters and Kashima.

1 General Information

A pair of 11-m diameter antennas were operated by the VLBI group of the Space-Time Standards 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 Koganei 11-m antenna is located at the NICT headquarters in Koganei, Tokyo (Figure 1). These two 11-m VLBI antennas (Figure 2) were built together with two other VLBI stations to create the Key Stone Project (hereafter referred as KSP).

NICT Kashima Space Technology Center

NICT KSP Network Station

IVS 2019+2020 Biennial Report

[1] http://auscope.phys.utas.edu.au/aov/index.html

The aim of the KSP [1] was monitoring 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 was terminated in 2001, two 11-m antennas at Miura and Tateyama were transferred to Gifu University and Hokkaido University and used for radio astronomy. Two antennas at Kashima and Koganei were used for geodetic observations and technology developments. Their regular participation in IVS sessions started after the “Great East Japan Earthquake” in March 2011.

1.1 Data Acquisition Systems

The K5/VSSP32 [2] system, which has four channels of video band signal input per unit, is deployed at both

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

stations. The data stream is recorded on a standard Linux file system in K5/VSSP32 format[2]. This software tool [3] has been used for data format conversion from K5/VSSP32 to Mark IV, VLBA, and Mark 5B.

All the VLBI data acquired by NICT were exported to Correlation Centers over the network from data servers at Kashima. Network connection at 10 Gbps was provided by the High Speed R&D Network Testbed JGN. All NICT VLBI stations (i.,e., Kashima 11-m, Koganei 11-m, and Kashima 34-m) share the same 10-Gbps network.

Table 1 VLBI sessions of the Kashima and Koganei stations in 2019–2020.

Kashima 11-m	**2019**	**2020**
IVS & AOV	aov032 aov035 apsg44 apsg45 t2130 t2131 t2132	—
Koganei 11-m	**2019**	**2020**
IVS & AOV	apsg44 apsg45 crf112 crf113 crf115 t2130 t2131 t2133 t2135 t2136 aov032 aov035 aov038 aov039 aov041 aov042	apsg46 apsg47 t2137 t2138 t2139 t2140 t2141 t2142 t2143 aov044 aov047 aov048 aov049 aov050 aov051 aov053 aov054
Freq. transfer	in001 in002	

2 Events and Activities during the Past Two Years

The two 11-m antennas participated in the IVS and AOV sessions as listed in Table 1.

2.1 Kashima 11-m antenna

In preparation of T2133 on 23 July 2019, serious degradation of sensitivity was found for the Kashima 11-m station. It was due to rainwater filled in the waveguide feed of its S/X-band receiver system that was caused by breakage of the feedome sheet of the antenna (Figure 3). Although we made tentative repair by closing the hole, additional holes were found a few weeks later. Since the feedome top is made of a strong and durable sheet, it was unlikely to be caused by the accidental hit of falling debris. Bird-repelling needles were equipped at the top of the feed cone; thus, we never had such trouble before. Though it was suspected to be caused by sharp bill such as woodpecker, we could not identify the reason. Finally, the dismantlement of the 11-m antenna together with the Kashima 34-m antenna was decided. As a consequence, T2132 on 21 May 2019 became the last VLBI observation for the Kashima 11-m antenna.

[2] https://www2.nict.go.jp/sts/stmg/K5/VSSP/vssp32_format.pdf
[3] https://www2.nict.go.jp/sts/stmg/K5/VSSP/index-e.html

Fig. 3 A hole was found in the feedome sheet of the Kashima 11-m antenna in July (left). The hole was closed by tentative repair. However, additional holes were found in August (right).

Table 2 DOMES numbers of the instruments that were part of the local tie surveys. Note that the SLR geodetic ground marker (Site reference point: SRP) is located separately from the intersection point of the azimuth/elevation axes of the SLR telescope.

DOMES Number/SLR Code	Site Name	CDP	GNSS	Description
21701S001	KASHIMA	1856		26-m VLBI antenna
21701M002	KASHIMA	7335		SLR geodetic ground marker (Site Reference Point:SRP)
21701S004	KASHIMA	1857		34-m VLBI antenna
21701S006	KASHIMA	7334		Steerable 11m Cassegrain VLBI antenna/intersection of axes
21701S007	KASHIMA		KSMV	Ashtech Z-XII with GEODETIC L1/L2 antenna/ARP
KASL(SLR)	KASHIMA			SLR telescope Az/El axis cross point at Kashima KSP
21704M001	KOGANEI	7328		SLR geodetic ground marker (Site Reference Point:SRP)
21704S002	KOGANEI	7308		SLR CRLLAS IAR
21704S004	KOGANEI	7327		Steerable 11m Cassegrain VLBI antenna/intersection of axes
21704S005	KOGANEI		KGNI	Ashtech Z-XII with GEODETIC L1/L2 antenna/ARP
KOGL(SLR)	KOGANEI			SLR telescope Az/El axis cross point at Koganei KSP
21739M001	MIURA	7337		SLR geodetic ground marker (Site Reference Point:SRP)
21739S001	MIURA	7336		Steerable 11m Cassegrain VLBI antenna/intersection of axes
MIUL(SLR)	MIURA	7337		SLR telescope Az/El axis cross point at Miura KSP
21740M001	TATEYAMA	7339		SLR geodetic ground marker (Site Reference Point:SRP)
21740S001	TATEYAMA	7338		Steerable 11-m Cassegrain VLBI antenna/intersection of axes
TATL(SLR)	TATEYAMA			SLR telescope Az/El axis cross point at Tateyama KSP

2.2 Koganei 11-m Antenna

The Koganei 11-m antenna has participated in geodetic VLBI sessions conducted by the IVS and AOV. It has been pointed out in the correlator reports that the correlation amplitude of the Koganei 11-m antenna-related baselines was smaller than expected from its SEFD values. Regarding this issue for the S-band receiver, it is already known that strong RFI coming from cell phone base stations has been sometimes saturating the first low noise amplifier (LNA) for this antenna. However, the reason for smaller correlation amplitudes at X-band is not clear yet. Detailed local investigation is required though, and visiting Koganei from Kashima was restricted due to COVID-19 in 2020; thus, studying this issue remains as a future task.

Antenna time is shared with the Space Environment Laboratory (SPEL), when the antenna is free from VLBI observation. Receiving down-link signal of the STEREO satellite[4] was performed for monitoring of solar activity.

[4] http://www.nasa.gov/mission_pages/stereo/main/index.html

2.3 Local Tie Information

The KSP was a project to monitor crustal deformation around the Tokyo metropolitan area with multiple space-geodetic techniques of VLBI, SLR, and GPS. With the aim of comparison and confirming the consistency of the different space-geodetic techniques, local surveys were conducted in the KSP during 1996–2000. In addition, another survey was conducted at the Koganei site in 2013 for the last time. It was triggered by construction of 1.5-m diameter new optical telescope at Koganei for the purpose of optical communication with satellites.

Responding to the call for participation to ITRF2020, these survey data were summarized and submitted to the ITRF Combination Center. The same data is available on the NICT website.[5] Table 2 shows the DOMES numbers of the instruments that were measured in the local tie survey at each site.

3 Future Plans

The Koganei 11-m antenna will continue to participate in VLBI sessions of the IVS and AOV in 2021 and beyond. The cause of the discrepancy between the correlation amplitude of the VLBI observation and single dish antenna sensitivity needs to be investigated.

[5] https://ksp.nict.go.jp/survey/Supplment/KSP-colloc.html

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