

# Tsukuba 32-m VLBI Station

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**Abstract** The Tsukuba 32-m VLBI station was operated by the Geospatial Information Authority of Japan from 1998, and it stopped its operations at the end of 2016. This report summarizes activities of the Tsukuba 32-m VLBI station and the Ishioka Geodetic Observing Station, which is a successor to the Tsukuba 32-m VLBI station and fully compliant with the VGOS concept, in 2015 and 2016. Tsukuba 32 m participated in 139 24-hour sessions and 368 Intensive sessions, and Ishioka participated in 61 24-hour sessions and 31 Intensive sessions in accordance with the IVS Master Schedules of 2015 and 2016. In addition to these legacy sessions, Ishioka carried out collaborative broadband observations with several IVS stations, and we confirmed the compatibility of equipment between Ishioka and the other stations.

## 1 General Information

The Tsukuba 32-m VLBI station (Figure 1, hereafter Tsukuba 32 m) is located at the Geospatial Information Authority of Japan (hereafter GSI) headquarters in Tsukuba science city, which is about 50 km to the northeast of Tokyo. Ishioka Geodetic Observing Station (Figure 2, hereafter Ishioka) is located about 17 km to the northeast of the Tsukuba 32 m. In addition to these stations, GSI had operated two regional stations, Chichijima and Aira (Figure 3) and terminated their operations in March 2015, because these stations were

originally established for maintaining the geodetic reference frame of Japan and the role had been replaced by GNSS continuously operating reference stations. Therefore, domestic VLBI sessions, JADE (Japanese Dynamic Earth observation by VLBI) which had been carried out by GSI since 1996 in order to maintain the reference frame of Japan and to monitor plate motions, were also terminated in 2015.

In 2015 and 2016, Tsukuba 32 m participated in international sessions as in the past. Ishioka also started to participate in legacy S/X sessions with Tsukuba 32 m in order to determine the accurate relative position between Tsukuba 32 m and Ishioka. In addition to these legacy sessions, Ishioka observed several broadband sessions compatible with the VGOS frequency setup.



**Fig. 1** Tsukuba 32-m VLBI station.

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2. Advanced Engineering Service Co., Ltd.



**Fig. 2** Ishioka Geodetic Observing Station.



**Fig. 3** Geodetic VLBI network in Japan.

## 2 Component Description

The specifications of the antennas of Tsukuba 32 m and Ishioka are summarized in Table 1.

## 3 Staff

Regular staff members belonging to the VLBI group of GSI are shown in Table 2. In April 2015, Jiro KURODA was replaced by Ryoji KAWABATA, Shinobu KURIHARA was replaced by Takahiro

WAKASUGI, and Masayoshi ISHIMOTO joined the group for operation of the stations. In April 2016, Kojin WADA was replaced by Basara MIYAHARA as a supervisor, and Tomoo TOYODA, and Michiko UMEI joined the group in order to take over the work of Yoshihiro FUKUZAKI. Primary routine operations were outsourced to a private company, Advanced Engineering Service Co., Ltd. (AES). Syota MIZUNO and Takafumi ISHIDA were replaced by Katsumi NUMAJIRI and Masatoshi NAKAGAWA as the operators in April 2016.

**Table 1** Specifications of the Tsukuba 32-m and Ishioka 13-m antennas.

Antenna	Tsukuba 32 m	Ishioka 13 m
Owner and operating agency	GSI	GSI
Year of construction	1998	2014
Radio telescope mount type	Az-EI	Az-EI
Antenna optics	Cassegrain	Ring focus
Diameter of main reflector	32 m	13.2 m
Azimuth range	10-710°	-70-430°
Elevation range	5-88°	0-90°
Az/EI drive velocity	3°/sec	12°/sec
Tsys at zenith (X/S)	50 K / 65 K	52 K / 49 K
SEFD (X/S)	320 Jy / 360 Jy	1500 Jy / 1400 Jy
RF range (X)	7780-8980 MHz	8180-8980 MHz
RF range (S with BPF)	2215-2369 MHz	2200-2400 MHz
RF range (Broadband)	–	3-14 GHz
Recording terminal (X/S)	K5/VSSP32 ADS3000+ with DDC	K5VSI ADS3000+ with DDC
Recording terminal (Broadband)	–	K6/iDAS

**Table 2** Member list of the VLBI group of GSI (2016).

Name	Main Function
Basara MIYAHARA	Supervisor
Ryoji KAWABATA	Management, IVS Directing Board member, The secretary of AOV
Masayoshi ISHIMOTO	Operation
Takahiro WAKASUGI	Correlation, Analysis
Tomoo TOYODA	Outreach, Co-location
Michiko UMEI	Operation
Katsumi NUMAJIRI	Operation (AES)
Masatoshi NAKAGAWA	Operation (AES)
Toshio NAKAJIMA	System engineer (NTT-ATC)

## 4 Current Status

### 4.1 Geodetic VLBI Observations

The number of regular sessions of GSI stations designated by the IVS Master Schedules of 2015 and 2016 are shown in Table 3. Tsukuba 32 m participated in 139 24-hour VLBI sessions and 368 Intensive one-hour sessions for dUT1 measurement including 66 INT1 sessions as a replacement for the Kokee station. Ishioka participated in 61 24-hour VLBI sessions, 31 Intensive one-hour sessions, and three international broadband sessions (see Section 4.2). The other GSI antennas, Chichijima and Aira, participated in ten 24-hour VLBI sessions by the end of March 2015.

**Table 3** Number of regular sessions observed by GSI in 2015 (left) and 2016 (right).

Sessions	Tsukuba 32-m	Ishioka	Aira	Chichijima
IVS-R1	42 / 50	7 / 25	–	–
IVS-T2	6 / 6	3 / –	1 / –	1 / –
APSG	2 / 2	– / 1	–	–
AOV	6 / 6	6 / 2	1 / –	–
JADE	18 / –	17 / –	4 / –	2 / –
JAXA	1 / –	–	1 / –	–
IVS-INT1	– / 66	–	–	–
IVS-INT2	102 / 100	– / 31	–	–
IVS-INT3	50 / 50	–	–	–
IVS-VGOS	– / –	– / 3	–	–

### 4.2 Broadband Observations

Ishioka carried out the first international collaborative broadband observing with both the Hobart 12-m antenna in Australia and the Kashima 34-m antenna in Japan in August 2016. The first fringes of the international broadband observing were detected between Ishioka and Hobart. In the observing, we used an AD sampler, K6/GALAS, developed by NICT (Sekido et al., 2015) instead of our frequency Up-Down Converter and our new sampler, K6/iDAS.

In addition to the first observing, Ishioka participated in three VGOS Trial sessions in August and September 2016. Fringes were not detected at Ishioka in the first Trial session. However, in the latter two

sessions, fringes were successfully detected, and they were the first fringes for our new system with our frequency Up-Down Converter and an AD sampler, ADS3000+. This means that the equipment of Ishioka is compatible with that of the other IVS stations which participated in the Trial sessions. Our new sampler, K6/iDAS, is undergoing validation and will be used for future broadband sessions after the validation in the near future.

### 4.3 Co-location Survey at Tsukuba 32-m and Ishioka

In January 2015, we performed a field co-location survey at Ishioka in order to measure accurate relative positions between the reference points of the Ishioka 13-m VLBI antenna and an antenna of a GNSS station which is planned to be an IGS tracking station. The relative position of the two points was determined with precisions of 0.6 mm in horizontal and 0.4 mm in vertical, respectively. In October 2016, we also performed a field co-location survey at Tsukuba 32 m. This was the last opportunity for Tsukuba 32 m to conduct a co-location survey. The data is still undergoing processing, and the latest local tie will be available in March 2017.

## 5 Ishioka as a Successor to Tsukuba 32 m

Operation of the Tsukuba 32 m was terminated at the end of 2016, and it will be dismantled by the end of March 2017. In 2017, Ishioka continues to participate in S/X legacy 24-hour and Intensive sessions as a successor to the Tsukuba 32 m and also participates in IVS VGOS campaign sessions. We are planning to increase opportunities to participate in the VGOS campaign sessions depending on the schedule planned by IVS.

## References

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