Ishioka Geodetic Observing Station – 13.2-m Radio Telescope

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Abstract The Ishioka Geodetic Observing Station is owned and operated by the Geospatial Information Authority of Japan. The 13.2-m radio telescope at the station successfully contributed to IVS regular observations during 2017 and 2018, succeeding the Tsukuba 32-m telescope, which was decommissioned at the end of March 2017. In addition to the regular observations, VGOS broadband observations were also performed.

1 General Information

The Ishioka Geodetic Observing Station (Figure 1) is located at about 70 km to the northeast of Tokyo and 17 km to the northeast of the headquarters of the Geospatial Information Authority of Japan (GSI) in Tsukuba (Figure 2). The observing station is owned and operated by GSI. It stands on firm ground atop a hill. It is equipped with a 13.2-m radio telescope which consists of a VGOS compliant antenna designed by MT Mechatronics (MTM), and two GNSS observation stations, one of which is registered as an IGS station. The telescope and the operation building had been completed by March 2016, and the VLBI station had participated in IVS regular observations as a network station in parallel with the Tsukuba 32-m radio telescope. Since 2017, the station has been fully participating in S/X legacy 24-hour and Intensive sessions as a successor to the Tsukuba 32-m telescope, which was decommissioned at the end of 2016 [1]. As a VGOS station, the station also participated in VGOS campaign sessions and some VGOS Trial sessions coordinated by IVS.

1. Geospatial Information Authority of Japan
2. Advanced Engineering Service Co., Ltd.

Ishioka Network Station

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Fig. 1 Ishioka 13.2-m radio telescope at the Ishioka Geodetic Observing Station.

2 Component Description

The specifications of the Ishioka 13.2-m radio telescope are summarized in Table 1. The Ishioka station uses two different types of feed depending on the type of observing, namely, tri-band feed for S/X observations and QRFH for broadband observations. The QRFH is equipped with a 3 GHz high-pass filter to mitigate the effect of RFI around the 2 GHz band. It takes about one week to replace feeds and adjust the equipment.

In both S/X and broadband observing, the RF signal is transmitted to the operation building directly with-

Fig. 2 Location of Ishioka Geodetic Observing Station.

out frequency conversion. Then, the RF signal is down-converted to an IF signal and digitized. In S/X observing, a down-converter is used, and the frequency of the IF signal is 512–1,024 MHz. In broadband observing, the RF signal is down-converted by an Up/Down Converter (UDC), and the frequency of the IF signal is 1,024–2,048 MHz.

The Field System ver. 9.10.5 (FS9) is used to control the antenna and relevant devices.

3 Staff

Regular staff members belonging to the VLBI group of GSI are shown in Table 2. As of December 2018, the VLBI group of GSI consists of seven staff members and a contract operation staff member.

Table 1 Specifications of the Ishioka 13.2-m radio telescope.

Parameter	Ishioka 13.2-m radio telescope
Owner and operating agency	GSI
Latitude	N36°12'33.09"
Longitude	E140°13'8.24"
Altitude	112.8 m
Year of construction	2014
Radio telescope mount type	Az-El
Antenna optics	Ring focus
Diameter of main reflector	13.2 m
Azimuth range	180° +/- 250°
Elevation range	0-90°
Azimuth drive velocity	12°/sec
Elevation drive velocity	6°/sec
Tsys at zenith (X/S)	50 K / 300 K
Tsys at zenith (Broadband)	H-pol:100 - 150 K (3 - 8 GHz) 200 - 400 K (8 - 14 GHz) V-pol : 100 - 200 K (3 - 8 GHz) 200 - 500 K (8 -14 GHz)
SEFD (X/S)	1500 Jy / 2200 Jy
SEFD (Broadband)	H-pol : 2000 - 3000 Jy (3 - 10 GHz) 3000 - 5000 Jy (10 - 14 GHz) V-pol : 3000 - 4000 Jy (3 - 10 GHz) 3000 - 5000 Jy (10 -14 GHz)
RF range (X)	8192-9104 MHz
RF range (S with BPF)	2170-2425 MHz
RF range (Broadband)	3-14 GHz
Recording terminal	ADS3000+ sampler & K5/VSI data recording terminals
Data capacity	93 TB
Hydrogen maser	VCH-1003M (VREMYA-CH) SD1T03A (Anritsu, backup)

Table 2 Member list of the VLBI group of GSI (2017–2018).

Name	Main Function	Remarks
Hiroshi MUNEKANE	Supervisor	Apr. 2018 -
Tadao KIKKAWA	Operation	Nov. 2018 -
Shinobu KURIHARA	Management	Apr. 2017 -
Takahiro WAKASUGI	Correlation and Analysis IVS Directing Board member Chair of AOV	
Michiko UMEI	Correlation and Analysis	Operation (-Aug. 2018)
Haruka UESHIBA	Operation	Apr. 2018 -
Saho MATSUMOTO	Operation	Nov. 2018 -
Kentaro NOZAWA	Operation (AES)	Apr. 2018 -

4 Current Status

4.1 S/X Observations

Since January 2017, the Ishioka station has regularly participated in Intensive one-hour sessions instead of the Tsukuba 32 m. Since April 2017, Ishioka has also participated in 24-hour sessions frequently. The number of regular sessions in which Ishioka was involved following the IVS Master Schedules of 2017 and 2018 is shown in Table 3. Note that AOV sessions are observations designed for enhancing positioning accuracy in the Asia-Oceania region, and GSI contributes as a scheduler through preparing the schedules of some of the AOV sessions. Most of the AOV sessions are carried out at a total recording rate of 1 Gbps. In addition, the Ishioka station participated in two geodetic VLBI observations with the Usuda 64-m telescope operated by JAXA in order to determine the geocentric coordinates of the telescope for their deep space mission.

The Ishioka station is connected to a broadband network called *SINET5*, operated by the National Institute of Informatics (NII), with a 10 Gbps dedicated cable. The observation data is converted from K5 to Mark 5 format as necessary and sent to a correlator by jive5ab or tsunami. Observations are remotely operated from the headquarters of GSI at Tsukuba. The observation procedure is automated, and operations at night or on a holiday are unattended. If trouble occurs at night or on a holiday, a notification e-mail is sent to operators.

Several problems which affected observations have occurred so far. From May to August 2017, some observations are missing due to an error with releasing the brake or stow pin. Regarding the error of releasing the brake, we increased the number of times to execute the FS9 command *ant_act* in a snap file because the brake is sometimes not released, depending on the timing of executing the command. On the other hand, it is still not clear what caused the error with releasing the stow pin. However, the error has become less frequent after September 2017 and has occurred only once every few months on average. Antenna control trouble caused by condensation around the elevation encoder has occurred several times. In order to prevent dew condensation, two fans were installed around the encoder to circulate the air in the Azimuth cabin. More antenna control trouble occurred in September 2018. At that time, the station could not observe for about ten days. The trouble was caused by the breaking down of one of the communication modules to the antenna control. After replacing the module, the trouble was resolved.

Table 3 The number of regular sessions in 2017 and 2018.

Sessions	2017	2018
IVS-R1	44	31
IVS-R4	30	29
IVS-T2	4	4
APSG	2	1
AOV	3	9
IVS-INT1	19	-
IVS-INT2	91	71
IVS-INT3	40	32

4.2 Broadband Observations

The Ishioka station carried out broadband observations from November to December in 2017 and from June to September in 2018. The Ishioka station participated in the CONT17 campaign as one of the six VGOS stations and in some 24-hour VT sessions. The numbers of VT sessions in which Ishioka participated are two in 2017 and seven in 2018. In addition, the Ishioka station participated in international collaborative broadband observations with the Kashima 34-m antenna and the Hobart 12-m antenna. From August through September 2018, Ishioka carried out three collaborative observing sessions with the Hobart 12 m. The observing frequency setup was the same as for VT sessions, and the observation time was 30 minutes or one hour. At the third session, fringes were detected on all frequency bands.

In August 2018, the Ishioka station also participated in experiments for the distant frequency comparison project conducted by National Institute of Information and Communications Technology (NICT), as the only VGOS station in Japan. In the experiments, broadband observations (6, 8.5, 10, and 11 GHz with a bandwidth of 1 GHz) were carried out between Ishioka and small telescopes which were set by NICT at Koganei and the Medicina Radio Astronomical Station (National Institute for Astrophysics; INAF) [2]. Fringes were successfully detected for each band.

4.3 Co-location Survey

In November 2018, we performed a field co-location survey at the station in order to measure an accurate local tie vector between the Ishioka 13.2-m radio telescope and the antenna of the IGS tracking station ISHI. To determine the invariant point of the telescope, we carried out two different ways. One is the conventional *outside* method in which we put a target enclosing a retro reflector outside of the telescope and measure its position from pillars around the telescope (Figure 3) [3]. The other is called the *inside* method, in which we put a target mirror inside of the azimuth cabin and measure its position from the stage near the Az-El intersection of the telescope (Figure 4). The data is currently undergoing processing, and we will soon compare the results by the two methods.

Fig. 3 Picture of field co-location survey by *outside* method.

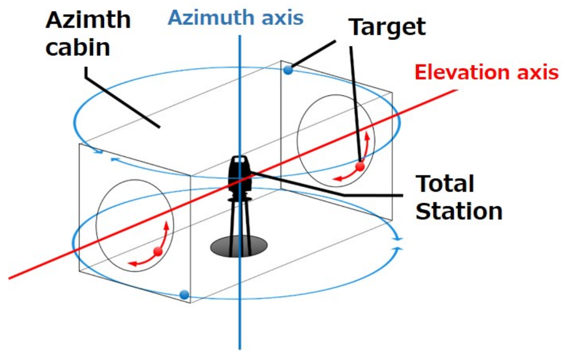

Fig. 4 Schematic diagram of the *inside* method.

5 Outlook

The Ishioka 13.2-m radio telescope will continue to participate in S/X legacy 24-hour and Intensive sessions and in VGOS experiments from 2019 on. In parallel with that, we are planning to start an investigation for "Mixed Mode" observing with the QRFH. To receive an S-band signal by QRFH, it is necessary to update its band pass filter to extend its lower limit to 2 GHz from the current 3 GHz, while avoiding the effect of RFI around 2 GHz.

References

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