Status of the Ishioka VLBI Station for the Past Two Years

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Abstract The Ishioka 13-m VLBI telescope has participated in IVS sessions since 2015. From 2020 through 2021, it could not be involved in the scheduled sessions for several months because of system troubles. This report describes the process of the troubleshooting and our efforts to prevent the recurrence of these problems.

Keywords Ishioka, Troubleshooting

1 Introduction

The Ishioka VLBI observing station (hereafter "Ishioka", Figure 1) participates in IVS observing all year round. Ishioka is one of the VGOS stations and is participating in both the VGOS and S/X sessions by changing its receiver. In the past few years, we had experienced some troubles. In 2020 and 2021, we could not avoid stopping observing for several months because of a problem with the driving system for the elevation drive. In addition, in early 2020, a strong noise occurred in V-polarization with the VGOS receiver, and Ishioka was not able to provide the complete observational data until the problem was fixed in March 2022. We report the overview of these problems, the process of troubleshooting, and our efforts to avoid having the same problems occur again.

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Fig. 1 Ishioka VLBI observing station.

2 Overview of Troubles and Troubleshooting

2.1 Motor Trouble in 2020

In June 2020, the telescope emergently stopped frequently, only for elevation (EL) driving around EL 60 degrees during observing because of errors caused by the motor for the elevation drive. We suspended the observing. First, a problem with the software was suspected, but there was no problem with it. Next, the hardware was investigated. It was found that the torque value for one of the motors for elevation driving had a vibration where the telescope points to EL 60 degrees (Figure 2), and the teeth of a gear rim were worn to around 1 mm in thickness where the teeth engage when the telescope points to EL 60 degrees. Therefore, it was revealed that the vibration generated by the worn teeth of the gear rim caused the motor over-torque, and the telescope emergently stopped. The manufacturer

assumed that lack of lubricant on the gear teeth had made the gear teeth worn. (However, it has not been made clear why only one side of the gear was worn even though there are two gear rims for elevation driving and they were maintained in the same way.) After the threshold of the torque limiter was raised, the error has not occurred. To prevent the teeth from being whittled down more, the surface of the worn gear teeth was polished by a specialist, and the contact surface of the teeth was changed by software. Ishioka resumed observing at the end of November 2020. It means that the operation was interrupted for five months.

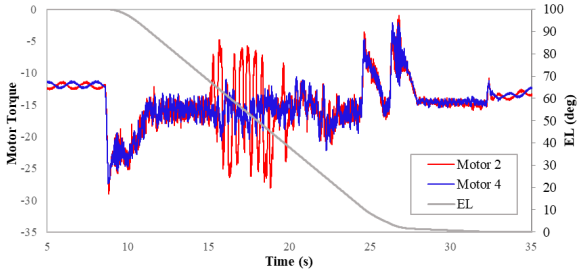

Fig. 2 Torque value of the motors monitored by ACU. The red and blue lines show the torque of Motors 2 and 4, respectively. The gray line shows the EL angle. Motor 2 shows the abnormal vibration around the EL angle of 60 degrees.

2.2 Motor Trouble in 2021

In May 2021, trouble with another motor for the elevation drive happened, and the telescope stopped frequently, only for EL driving at various EL degrees during observing. This time, a servomotor amplifier error occurred, and the cause was suspected to be a failure of the encoder, encoder cable, control board, or electric contact. Swapping the control board and the cable for the encoder and installing a new control board were conducted, but the error was not resolved. Once the motor was dismantled and reassembled by the manufacturer, the error never happened again. Thus, the error seemed to have been caused by a contact failure of the motor encoder. While we were investigating, we participated in observing as much as possible with a slow slew speed (EL 3 deg/sec). As the telescope stopped frequently in spite of the slow speed, it was necessary to monitor the telescope during observing. We restarted observing with a normal slew speed (EL 6 deg/sec) in November 2021, so it took more than five months to return to observing completely.

2.3 Noise in V-polarization with the VGOS Receiver

Noise had occurred in V-polarization with the VGOS receiver since January 2020, and Ishioka had not been able to provide fine observational data (Figure 3). From the investigation, it was made clear that the LNA for V-polarization on the VGOS receiver was broken and caused the noise. After replacing the LNA, the problem was resolved, and we were able to detect clear fringes with a fringe test between Onsala and Ishioka in March 2022. Ishioka has participated in VGOS observing in good condition starting from VO2083 on March 24th.

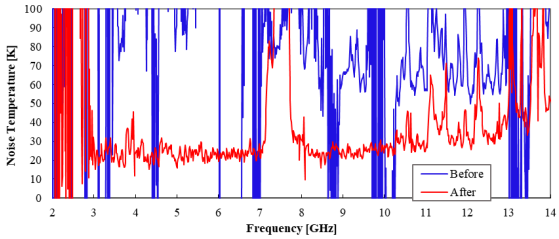

Fig. 3 Noise temperature before (blue) and after (red) replacing the LNA.

3 Our Efforts to Prevent the Same Trouble

To prevent recurrence of the same trouble, we reconsidered how to maintain the telescope. In the case of the motor trouble in 2020, the reason for the worn teeth of the gear was assumed to be a lack of lubricant on the gear rim. To avoid this, the frequency of the lubrication was increased by two times by changing the setting of the auto lubrication system. In addition, to spread the oil on all of the gear teeth, we shuttled the telescope in the EL direction between 0 and 100 degrees before and after each observing session. Furthermore, we increased the frequency of the regular maintenance by the manufacturer's Japanese agency (from once a year to twice a year). In addition to the regular maintenance,

we conducted maintenance focused on the gear and motor. Specifically, we check the motor torque and the rotation speed frequently if there is something wrong with the motor, and the agency also analyzes the data once a month. In addition, the agency checks the gear teeth directly when the driving degree total for elevation reaches a certain count (every 90,000 degrees at the moment). Since the trouble in 2021, we have begun to make efforts to achieve redundancy for parts of the observing instruments and modules for the telescope driving system. One of the reasons it had taken time to solve the problem was taking time to purchase the necessary parts of the telescope to replace them. Being under the spread of coronavirus was suggested as one of the causes. Storing the spare parts helps us to investigate the cause of troubles promptly. Because GSI operates only one telescope, the unavailability of Ishioka has a large impact on its contributions as one of the IVS stations. As time goes by from the construction of the telescope, however, a further increase of trouble is anticipated. It is important to build up resilience to avoid interrupting observing for a long time when problems occur.

4 Conclusions

Ishioka was not able to participate in IVS sessions for several months because of two troubles with the telescope driving system in 2020 and 2021. The first one was caused by the worn teeth of a gear rim, and we enhanced the inspection to check the status of the telescope. The second trouble was caused by the contact failure of the motor encoder. In addition, from 2020, Ishioka data taken with the VGOS receiver in V-polarization contained noise. The noise was solved by replacing the LNA on the receiver. We have built up redundancy of the instruments to prevent prolonging down periods.

Acknowledgments

We appreciate the IVS participants for their understanding and cooperation with our irregular observing during the time that we had problems with the telescope.