

Working Status of Urumqi Station from 2019 to 2020

Hua Zhang, Ming Zhang

Abstract Urumqi Station is a very important VLBI station, which is responsible for a lot of VLBI joint interferometry and single-dish observation missions. The main observations include EVN, IVS, EAVN, pulsar arrival time, ammonia molecular survey, AGN variability, and so on. In order to fulfill those various tasks, we have introduced some new equipment and upgraded existing equipment in the past two years. We provide some details in this report.

1 Equipment Situation

1.1 Antenna System

The 26-meter radio telescope system is mainly composed of the antenna mechanical structure, the antenna feed sub-system, the axial angle encoding sub-system and the antenna servo sub-system. The mechanical structure of the 26-meter radio telescope adopts a modified Cassegrain antenna and a fully-steerable central symmetrical alt-azimuth wheel-rail antenna mount. The five-band feeds of Q, K, S/X, C, and L bands are distributed on the same focal plane, and the feed illumination can be changed by rotating the secondary reflector, which can be completed within one minute. The axial angle encoding sub-system adopts the shaft angle encoder to collect the position information of the antenna and the secondary reflector while it rotates to change the feed and feed it back to the antenna-control

and feed-change computer through the communication board to display and compare the information in real-time. The main function of the antenna control system is to accept the antenna position control instructions given by the antenna control computer and drive the antenna to accurately point to the radio source to be observed.

The main technical specs are as follows:

- Antenna type: modified Cassegrain antenna;
- Antenna mount: wheel-rail alt-azimuth mount;
- Main surface: 26 meters in diameter, accuracy ≤ 0.40 mm (rms);
- Secondary surface: 3 meters in diameter, accuracy ≤ 0.25 mm (rms);
- Pointing accuracy: $\leq 15''$;
- Working range: azimuth $\pm 270^\circ$ (relative to true south), elevation 5° – 88° (relative to horizontal), and
- Maximum rotation speed and acceleration: azimuth $1^\circ/s$, $0.5^\circ/s^2$; elevation $0.5^\circ/s$, $0.25^\circ/s^2$.

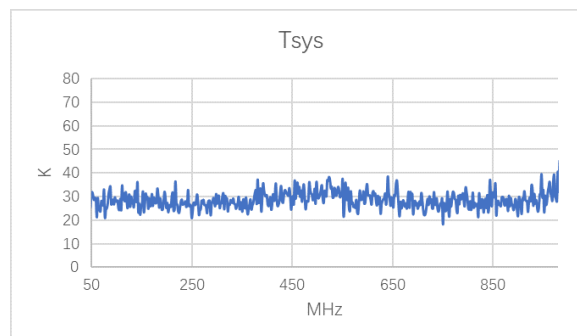


Fig. 1 X-band system temperature (right-handed circular polarization).

Xinjiang Astronomical Observatory (XAO), CAS

XAO-Nanshan Network Station

IVS 2019+2020 Biennial Report

1.2 Front-end Receiver System

At present, Urumqi Station is equipped with Q-, K-, S/X-, C-, and L-band receivers. The Q-band receiver, which is not operating at present, currently still needs to be debugged. The other band receivers are all working normally. From 2019 to 2020, the front-end receiving system has been mainly updated with the transmission line, and the optical fiber laying in the high-frequency warehouse and compressor room have been accomplished. In addition, a shielded cabinet is installed in the high-frequency warehouse to mitigate the RFI. The X-band receiver has been upgraded. Its low-temperature refrigerating unit, the normal temperature microwave frequency conversion unit, and the intelligent power supply system have also been replaced. The system temperature now is better than the temperature with the previous generation X-band receiver.



Fig. 2 The new C-band receiver.

Future plans include:

- To install a new C-band receiver, with an RF output range of 4–8 GHz, an intermediate frequency out-

put range of 0.1–1 GHz, and the adjustable local oscillator;

- To develop a 1–2 GHz broadband L-band refrigerated receiver, with a horizontal polarization output range of 1–2 GHz and a circular polarization output range of 0.1–0.6 GHz.

1.3 VLBI Terminal System

Currently, the main equipment of the VLBI terminals at Urumqi Station includes one DBBC2, one Mark 5B+, one Mark 5B, one Mark 6, four CDAS2, and six FS control computers. Among them, the DBBC2 and Mark 5B+ are mainly used for international joint observations of EVN, EVN FRB, IVS, EAVN, and others. The CDAS2 is mainly used for domestic VLBI joint observations. The Mark 6 has not been operating yet.



Fig. 3 Unpacking and accepting the Flexbuff.

In April 2020, due to the demand for domestic VLBI observation missions, two more sets of CDAS2 and FS control computers were added at Urumqi Station. In June of the same year, the purchase contract for the DBBC3 and the Flexbuff was signed. The Flexbuff has now arrived. The delivery period of the DBBC3 is delayed due to the international COVID-19 epidemic. It is expected to arrive after June 2021. From 2019 to 2020, Urumqi Station purchased 12 sets of diskpacks for EVN observations with a total capacity of 384 TB.



Fig. 4 VLBI observation room of Urumqi Station.

1.4 Time and Frequency System



Fig. 5 Pictures of the hydrogen atomic clocks: (left) Domestic hydrogen clock 1, (right) Domestic hydrogen clock 2.

Two new hydrogen atomic clocks (see Fig. 5), both of which were made in China, were purchased in 2019 and 2020. The currently operating clocks are mainly the hydrogen atomic clocks from Shanghai Astronomical Observatory, which are H123 and H124, and the backup clock is H152.

In 2020, we re-optimized the configuration of the time-frequency system's links and its equipment to improve the output performance of the system's signal. The environment of the hydrogen atomic clock room has been modified in all aspects to improve its operating performance.



Fig. 6 The new hydrogen clock room.

2 VLBI Observations Performed at Urumqi Station from 2019 to 2020

In 2019, Urumqi Station completed 1532.8 hours of effective VLBI observations. Among them, EVN sessions were performed 91 times, and 640.5 hours of effective observation time were obtained. EVN FRB sessions were performed 24 times, and 80 hours of effective observation time were obtained. EAVN sessions were performed 32 times, and 191.5 hours of effective observation time were obtained. IVS sessions were performed 12 times, and 291 hours of effective observation time were obtained. There were 99 performances of domestic joint surveys, and the effective observation time was 330 hours. Moreover, the total single-dish observation time was 4620 hours.

Table 1 Station IVS observing session statistics (Urumqi 2019). Note: The statistical data is compiled according to the data published on the IVS (International VLBI Service) website. Other unlisted sessions were not performed. The reasons for the non-implementations are conflicts with lunar exploration and IVS' cancellation of sessions.

No.	Session epoch	Session code	Data rate (Mbps)	Data format
1	2019-031 UT 18:30	R4879	128	Mark 5B+
2	2019-078 UT 17:30	APSG44	128	Mark 5B+
3	2019-079 UT 18:00	AOV033	128	Mark 5B+
4	2019-087 UT 18:30	R4887	128	Mark 5B+
5	2019-093 UT 18:00	AOV034	128	Mark 5B+
6	2019-106 UT 17:30	APSG45	128	Mark 5B+
7	2019-107 UT 17:30	R4890	128	Mark 5B+
8	2019-129 UT 18:30	R4893	128	Mark 5B+
9	2019-220 UT 18:30	R4906	128	Mark 5B+
10	2019-253 UT 17:30	CRF113	128	Mark 5B+
11	2019-345 UT 18:00	CRF115	128	Mark 5B+
12	2019-233 UT 18:00	CZ002A	128	Mark 5B+

Table 2 Station IVS observation experiment statistics (Urumqi 2020). Note: The statistical data is compiled according to the data published on the IVS (International VLBI Service) website. Other unlisted sessions were not performed. The reasons for the non-implementations are conflicts with lunar exploration and IVS' cancellation of sessions.

No.	Session epoch	Session code	Data rate (Mbps)	Data format
1	2020-009 UT 18:30	R4928	128	Mark 5B+
2	2020-020 UT 10:00	AOV043	128	Mark 5B+
3	2020-089 UT 18:00	APSG46	128	Mark 5B+
4	2020-106 UT 17:30	CRF118	128	Mark 5B+
5	2020-134 UT 18:00	APSG47	128	Mark 5B+
6	2020-141 UT 18:00	AOV047	128	Mark 5B+
7	2020-177 UT 18:30	R4952	128	Mark 5B+
8	2020-182 UT 17:30	CRF119	128	Mark 5B+
9	2020-267 UT 18:00	AOV051	128	Mark 5B+
10	2020-281 UT 18:00	AOV052	128	Mark 5B+
11	2020-286 UT 10:00	CRF121	128	Mark 5B+
12	2020-317 UT 18:30	R4972	128	Mark 5B+

The statistics of IVS and land network observations in 2019 are compiled in Table 1. The sessions that have not been completed due to conflicts between national missions and other missions in 2019 are: AOV031, R4900, CRF112, AOV037, R4904, AOV038, and AOV040.

In 2020, Urumqi Station completed 2,051.3 hours of effective VLBI observations. Among them, EVN sessions were performed 43 times, and 296.9 hours of effective observation time were obtained. EVN FRB sessions were performed 20 times, and 131.7 hours of effective observation time were achieved. EAVN sessions were performed 36 times, and 242.4 hours of effective observation time were obtained. IVS sessions were performed 12 times, and 240 hours of effective observation time were obtained. There were 185 per-

formances of domestic joint surveys, and the effective observation time was 1132.7 hours. The total single-dish observation time was 3957 hours.

The statistics of IVS and land network observations in 2020 are compiled in Table 2. The sessions that have not been completed due to national missions and other mission conflicts in 2020 are: R4933, AOV046, AOV048, R4964, AOV051, R4974, AOV054, and R4976.