Urumqi Station Status Report

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Abstract Urumqi Nanshan Station serves as a critical VLBI (Very Long Baseline Interferometry) observation facility, participating in multiple international and domestic VLBI programs. Over the past two years, the station has enhanced its observational capabilities through equipment upgrades and new installations. Its current key observation programs include EVN (European VLBI Network), IVS (International VLBI Service for Geodesy and Astrometry), EAVN (East Asian VLBI Network), pulsar timing, AGN studies, EVN-FRB (Fast Radio Burst observations), and molecular line surveys.

1 Instrumentation Updates

1.1 Front-end Receiving System

The 26-meter telescope is equipped with five receiver systems (L, C, S/X, K, Q bands), featuring cryogenic technology, except S-band which is working at normal termperature. The Q-band, recently commissioned, completes the station's multi-frequency capabilities. The key updated specifications are the automation and the Q-band upgrade. The automation can be carried out as remote-controlled operations with rapid band-switching and real-time monitoring facilities. The Q-band receiver was successfully tested and debugged in 2023. Now all receiver systems are serving routine astronomical observations. The detailed technical parameters of each band receiver are shown in Table 1.

At present, the receiving system of the Nanshan 26-meter radio telescope has a full-fledged operating architecture, equipped with highly automated remote control capabilities. It now enables fast frequency band switching, parameter configuration, and real-time status monitoring (as shown in Figure 1).

The newly installed and now operating Q-band receiving system, as well as the stacked parameter monitoring modules and the power supply modules for IF amplifiers, frequency multipliers, power dividers, cryogenic compressors and expanders, has taken the last space in the RF cabin (as shown in Figure 2).

2 VLBI Backends

The main VLBI backends at the Urumqi Station currently includes one DBBC2, one DBBC3, one MK5B+, one Flexbuff, three MK6s, four CDAS2s, and six FS control computers. Among them, DBBC2/3, MK5B+/6 and Flexbuff are primarily used for international joint observations from EVN, EVN FRB, IVS, and EAVN. The CDAS2 is mainly used for domestic VLBI observations. In 2024, testing and debugging of the MK6+DBBC2 was completed, and it is capable of observing at a recording rate of 4 Mbps. To date, we have purchased 2 PB of disk capacity for VLBI observations, of which 1.1 PB of the diskpacks was allocated and delivered to the EVN for data processing according to a mutual agreement.

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Table 1 Receiver parameters for the Nanshan 26-m telescope.

Band	Wavelength	RF Range [GHz]	Polarization	Equivalent LO [GHz]	IF Range [GHz]	System Noise [K]
L	18 cm	1–2	Linear	0.9	0.2–0.8	25
L	18 cm	1.222–1.722	Circular	0.186	1.036–1.536	25
C	6 cm	4–8	Circular	3.93–6.976	0.07–1.024	26
S	13 cm	2.1–2.6	Circular	2	0.1–0.6	60
X	3.6 cm	8.2–9.1	Circular	8.1	0.1–1	60
K	1.3 cm	22–24.2	Circular	21.9–23.6	0.1–0.6	45
Q	7 mm	30–50	Circular	29.93–48.976	0.07–1.024	100

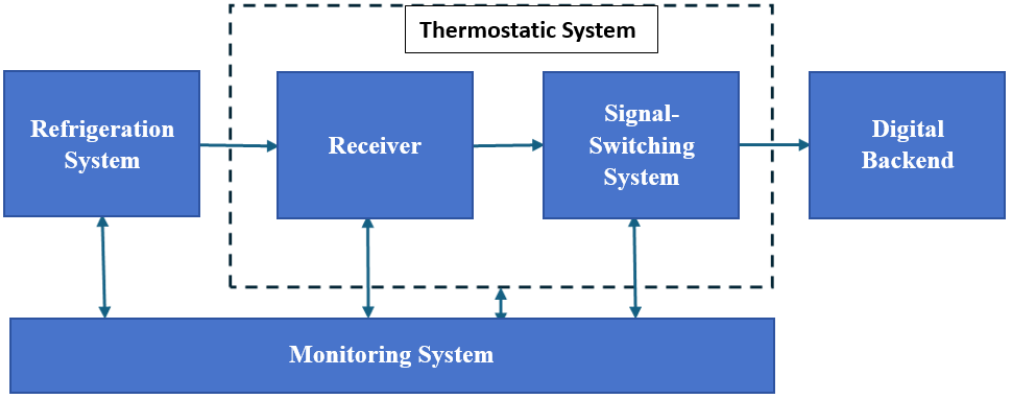

Fig. 1 Module diagram of the receiving system of the Nanshan 26-meter radio telescope.

3 VLBI Observation Status of Urumqi Station from 2023 to 2024

In 2023, the Nanshan Station completed 2,081.7 hours of effective VLBI observations, including:

- **77 EVN** sessions, with **732.92 hours** of effective observation time;
- **32 EVN FRB** sessions, with **274.18 hours** of effective observation time;
- **30 EAVN** sessions, with **209.3 hours** of effective observation time;
- **20 IVS** sessions, with **499.5 hours** of effective observation time;
- **128 domestic** joint sessions, with **347.1 hours** of effective observation time.

In addition, the **single-dish** observation time of the 26-meter telescope totaled some **4,766.16 hours**. The statistics of IVS and Crustal Movement Observation Network of China (CMONOC) observations in 2023 are as shown in Table 2.

In 2024, the sessions that failed to be completed due to conflicts with national tasks and other tasks are: aov080, aov082, aov084, and aov086. In 2024, the

Table 2 Statistics of IVS sessions at the Urumqi station in 2023. Note: The statistical data are compiled based on the data published on the website of IVS (International VLBI Service).

No.	Obs. Epoch	Obs. Code	Data Rate [Mbps]	Data Format
1	2023-017 UT 17:00	Aov079	128	MK5B+
2	2023-039 UT 18:00	Apsg52	128	MK5B+
3	2023-087 UT 17:30	Aov081	128	MK5B+
4	2023-089 UT 18:30	R41096	128	MK5B+
5	2023-110 UT 18:30	R41099	128	MK5B+
6	2023-137 UT 18:00	Aov083	128	MK5B+
7	2023-138 UT 18:30	R41103	128	MK5B+
8	2023-180 UT 18:30	R41109	128	MK5B+
9	2023-199 UT 17:30	Aov085	128	MK5B+
10	2023-213 UT 17:30	Aov086	128	MK5B+
11	2023-229 UT 18:30	R41116	128	MK5B+
12	2023-233 UT 18:30	Crf136	128	MK5B+
13	2023-236 UT 18:30	R41117	128	MK5B+
14	2023-242 UT 18:00	Apsg53	128	MK5B+
15	2023-250 UT 18:00	R41119	128	MK5B+
16	2023-268 UT 14:00	Aov087	128	MK5B+
17	2023-298 UT 18:00	Aov088	128	MK5B+
18	2023-318 UT 17:30	Aov089	128	MK5B+
19	2023-326 UT 17:30	Crf139	128	MK5B+
20	2023-340 UT 18:00	Aov090	128	MK5B+

Fig. 2 Q-band receiver of the Nanshan 26-meter radio telescope.

Nanshan Station completed 1,743.49 hours of effective VLBI observations, including:

- **44 EVN** sessions, with **294.66 hours** of effective observation time;
- **8 EVN FRB** sessions, with **50.54 hours** of effective observation time;
- **43 EAVN** sessions, with **275.26 hours** of effective observation time;
- **9 IVS** sessions, with **211.12 hours** of effective observation time;
- **236 domestic** joint sessions, with **906.74 hours** of effective observation time.

In addition, the **single-dish** observation time of the 26-meter telescope totaled some **3,860.18 hours**. The statistics of IVS and Crustal Movement Observation Network of China (CMONOC) observations in 2024 are as shown in Table 3.

Fig. 3 MK6 recording system in the EM-shielded basement at the Urumqi station.

Table 3 Statistics of IVS sessions at the Urumqi station in 2024. Note: The statistical data are compiled based on the data published on the website of IVS (International VLBI Service).

No.	Obs. Epoch	Obs. Code	Data Rate [Mbps]	Data Format
1	2024-023 UT 17:30	Crf140	128	MK5B+
2	2024-032 UT 18:30	R41140	128	MK5B+
3	2024-055 UT 12:00	Aov092	128	MK5B+
4	2024-242 UT 17:30	Aov094	128	MK5B+
5	2024-247 UT 17:30	Apsg54	128	MK5B+
6	2024-271 UT 19:00	Aov095	128	MK5B+
7	2024-334 UT 19:00	Aov096	128	MK5B+
8	2024-339 UT 18:00	Apsg55	128	MK5B+
9	2024-361 UT 18:30	R41187	128	MK5B+

Nanshan Station has maintained robust VLBI operations, with 2023–2024 upgrades significantly expanding its capabilities. Future focus includes optimizing scheduling to reduce task conflicts and further integrating Q-band observations.