

# Shanghai Station Report for 2019–2020

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**Abstract** This report summarizes the observing activities at the Sheshan station (SESHAN25) and the Tianma station (TIANMA65) in 2019 and 2020. It includes the international VLBI observations for astrometry, geodesy, and astrophysics and domestic observations for satellite tracking. We also report on updates and development of the facilities at the two stations.

## 1 General Information

The Sheshan station (SESHAN25) is located at Sheshan, 30 km west of Shanghai. It is hosted by Shanghai Astronomical Observatory (SHAO), Chinese Academy of Sciences (CAS). A 25-meter radio telescope is in operation at 3.6/13, 5, 6, and 18 cm wavelengths. The Sheshan VLBI station is a member of the IVS and the EVN.

The Tianma station (TIANMA65) is located in the western suburbs of Shanghai, Sheshan town, Songjiang district. It is jointly funded by the Chinese Academy of Sciences (CAS), Shanghai Municipality, and the Chinese Lunar Exploration Program. The telescope construction started in early 2009, and the majority of the mechanical system was completed in October 2012. On December 2, 2013, the Tianma65 telescope passed its acceptance evaluation. By design, the Tianma telescope—with a diameter of 65 meters it is one of the largest steerable radio telescopes in the world—is a multi-function facility, conducting

astrophysics, geodesy, and astrometry, as well as space science. By the end of 2014, Tianma65 was equipped with five cryogenic receiver systems (L, C, S/X, and Ku), with the expectation that another two high-frequency cryogenic receiver systems (Ka and Q) would be finished in 2015. The K band cryogenic receiver system was installed at the end of 2016. The CDAS and the DBBC2 have been installed at the Tianma 65-m telescope for the VLBI terminal.

The SESHAN25 and TIANMA65 telescopes take part in international VLBI sessions for astrometric, geodetic, and astrophysics research. Apart from its international VLBI activities, the TIANMA65 telescope spent a large amount of time on the Chinese Lunar Project, including testing before the launch of the Chang’e test satellite, as well as the tracking campaign after the launch and other single dish observations.

## 2 Component Description

In 2019, the SESHAN25 telescope participated in forty-one IVS sessions (including fifteen INT2/3 Intensive sessions). TIANMA65 participated in three IVS sessions.

In 2020, the SESHAN25 telescope participated in forty-one IVS sessions (including twenty-two INT3 Intensive sessions). TIANMA65 participated in three IVS sessions.

Table 1 provides a breakdown of the various session types observed in 2019 and 2020 for both SESHAN25 (Sh) and TIANMA65 (T6).

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**Table 1** Statistics of sessions observed.

Session Type	2019 (Sh)	2020 (Sh)	2019 (T6)	2020 (T6)
AOV	5	5	2	3
APSG	2	1	0	0
IVS-R1	17	11	0	0
IVS-T2	1	2	0	0
IVS-R&D	1	0	1	0
IVS-INT2	5	0	0	0
IVS-INT3	10	22	0	0

### 3 Current Status and Activities

#### 3.1 Antenna Maintenance at SESHAN25

From September 2019 to April 2020, we did some maintenance work on the rail track and the base of the Sheshan 25-m control room.



**Fig. 1** Antenna maintenance on the SESHAN 25-m telescope.

The Sheshan station encountered an antenna encoder problem during the R1972 session. Repairs were carried out from November to December.

#### 3.2 Antenna Maintenance at TIANMA65

The maintenance of the Tianma radio telescope focused on eliminating the noise from the pitch axes in 2020. First, we lifted the upper structure, which is around 1,300 tons including the rational pitch mechanism, back-up structure, quadripod, and sub-reflector. Then, we welded the pitch axes, replaced bolts, and unloaded the upper load. This work lasted two months, from 15th April to 15th June. Finally, the noise disappeared, and the pointing accuracy was better. In addition, the faulty motors and reducers were replaced, and the key mechanisms were greased. The telescope is in a good running state at present.

### 3.3 Other Tasks

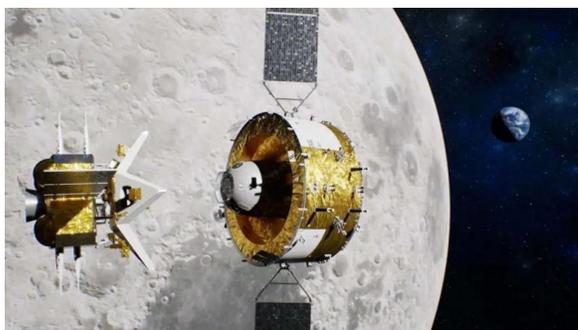
- China Mars Probe of Tianwen-1:** From the launch of Tianwen-1 on July 23, 2020 to December 30, 2020, 85 VLBI observations were made with the participation of the Tianma telescope. The accuracy of the VLBI time delay measurement was 0.1 ns, and the time delay rate was 0.3 ps/s, which was far better than the requirements of technical indicators. The VLBI orbit determination mission of Tianmwen-1 was successfully carried out, and three orbit corrections and one deep space maneuver were supported. VLBI is an essential means of the precise orbit determination of Tianwen-1 in each measurement and control stage, especially in the cruising stage and Mars capture stage, which plays a vital role.



**Fig. 2** Selfie of the Tianwen-1 probe, which released a small camera (2020.9.16 BJT 22:00: about 17.48 million km from Earth).

- Chang'e-5 Lunar Probe:** On November 24, China launched the Chang'e-5 spacecraft, comprising an orbiter, a lander, an ascender, and a returner. Chang'e-5 consisted of eleven flight stages, four probes, and different assemblies, which were highly challenging for monitoring and controlling events. As an important station of the VLBI orbital sub-system of Chang'e-5, the Tianma telescope has participated in the VLBI orbital determination and lunar surface positioning missions of nine flight stages, including Earth–Moon transfer, Braking, Orbiting the Moon, Landing and Descent, Lunar Operation, Power Ascent, Rendezvous and

Docking, Orbiting the Moon, and Moon–Earth Transfer. From its arrival on November 24 to the return of the samples, Chang’e-5 has been tracked and observed for 23 consecutive days, more than 10 hours a day. Successfully completing the orbit determination and positioning tasks of each flight stage, it will continue to carry out the orbiter expansion mission.



**Fig. 3** Chang’e-5 orbiter and ascender rendezvous and docking (their relative positions are accurately measured using the same beam).

#### 4 Staff of the Shanghai VLBI Station

Table 2 lists the group members at the Shanghai VLBI Station. The staff is involved in the VLBI program at the station with various responsibilities.

**Table 2** Staff at the Shanghai VLBI station. All e-mail addresses end with @shao.ac.cn.

Name E-mail	Background	Position and Duty
Zhiqiang Shen zshen	Astrophysics	Deputy Director
Qinghui Liu liuqh	Radio Technique	Chief Engineer
Bin Li bing	Microwave	Technical friend, Receiver
Bo Xia bxia	Electronics	VLBI friend, VLBI terminal
Jinqing Wang jwang	Electronics	Engineer, Antenna
Lingling Wang llwang	Software	Engineer, Timing system
Rongbing Zhao zhaorb	Software	Engineer, Timing system
Li Fu fuli	Ant. mechanical	Engineer, Antenna
Weiyue Zhong wyzhong	Microwave	Engineer, Receiver
Chao Zhang zhangchao	Microwave	Engineer, Receiver
Wei Gou gouwei	Electronics	Engineer
Linfeng Yu lfyu	Electronics	Engineer
Yongbin Jiang jyb	Electronics	Engineer
Yunxia Sun sunyunxia	HVAC	Engineer, Refrigeration
Gou Wen gw	Electronics	Engineer
Yongchen Jiang yongchen	Electronics	Engineer, Disk shipping
Zhiqiang Xu zqxu	Microwave	Engineer, Receiver
Zhang Zhao zhaozhaong	Electronics	Engineer

#### 5 Future Plans

In 2021, the Sheshan radio telescope will take part in thirty IVS sessions. The Tianma radio telescope will take part in five IVS sessions.

The telescopes will regularly track the Chang’e-4, Chang’e-5, and Tianwen-1 satellites in their lunar orbits.