

Shanghai Astronomical Observatory, P.R. China

TIANMA 65 Station Report

The Tianma station ('TIANMA65') is located in Sheshan town, Songjiang district, the western suburbs of Shanghai, China. It is built and jointly funded by the Chinese Academy of Sciences (CAS), Shanghai Municipality, and the Chinese Lunar Exploration Program. The Tianma radio telescope with a diameter of 65 meter, is a multifunction facility, conducting astrophysics, astrometry, geodesy, as well as space sciences researches with both single dish and VLBI observations. Besides of regular single dish observations on pulsars, spectral line and continuum sources, the telescope is a key member of the VLBI tracking system and spends a large amount of time on the Chinese Lunar and Mars Project, including the testing before the launch of the Chang'E satellites, and the tracking campaign after the launching. It is also actively involved in the international VLBI activities of astrometric, geodetic and astrophysical researches.

In 2019, Tianma 65m radio telescope participated in February, May and October sessions at 18, 6, 5 and 3.6 cm bands with the DBBC2 VLBI backend and Flexbuff. In 2020, Tianma 65m radio telescope participated in October session and partly of May session. We missed the February session due to antenna maintenance. We also missed most of session in May due to the Chinese Lunar and Mars missions.

Current Status and Activities

Receiver Maintenance in TIANMA65

All the seven sets of receivers (L, S/X, C, Ku, K, X/Ka, and Q band) of Tianma telescope are available for VLBI observation. And the L-band receiver was linear polarization.

Antenna Maintenance with TIANMA65

The maintenance of the TianMa radio telescope focused on eliminating the noise from the pitch axes in 2020. First, we lifted the upper structures which is around 1300 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 pointing accuracy showed better. In addition, the faulty motors and reducers were replaced and the key mechanisms were greased. The telescope shows good running state at present.

e-VLBI

More than ten e-VLBI experiments among the EVN have been carried out each year in 2019 and 2020 at a data rate of 2048 Mbps for each e-VLBI session.

EAVN Report

EAVN is the international collaborative VLBI array operated by institutes and stations distributed in China, Korea and Japan. Currently it consists of nine stations including three KVN stations, four VERA stations, Tianma and Urumqi stations. It started its open-use operations since the late half of 2018. EAVN mainly observes at K (22 GHz) and Q (43GHz) bands at a recording rate of 1Gbps, the 4Gbps recording mode is under testing. The C (6.7GHz) band observation is under evaluation and will be open in 2021A semester. The observations are carried out two semesters every year, the period of each semester is from the late of January to the middle of June and the early of September to the middle of January next year, respectively. The call for proposals is (https://radio.kasi.re.kr/eavn/proposal_info.php) also released twice per year in April and September. Tianma telescope provide about 200 hour machine time per semester. All the observational data are transferred to the correlator in KASI through the high-speed internet. Besides of routine general scientific observations, EAVN including Tianma telescope focuses on the intensive as well as contemporary observations on the two main target sources (Sgr A and M87) of the Event Horizon Telescope since 2017.

Chinese Mars probe of Tianwen-1

From the launch of Chinese Mars probe of Tianwen-1, Tianwen-1 on July 23, 2020 to December 30, 85 VLBI observations were made, with the participation of the Tianma telescope. The accuracy of VLBI time delay measurement was 0.1ns, and the accuracy of 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 for 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.

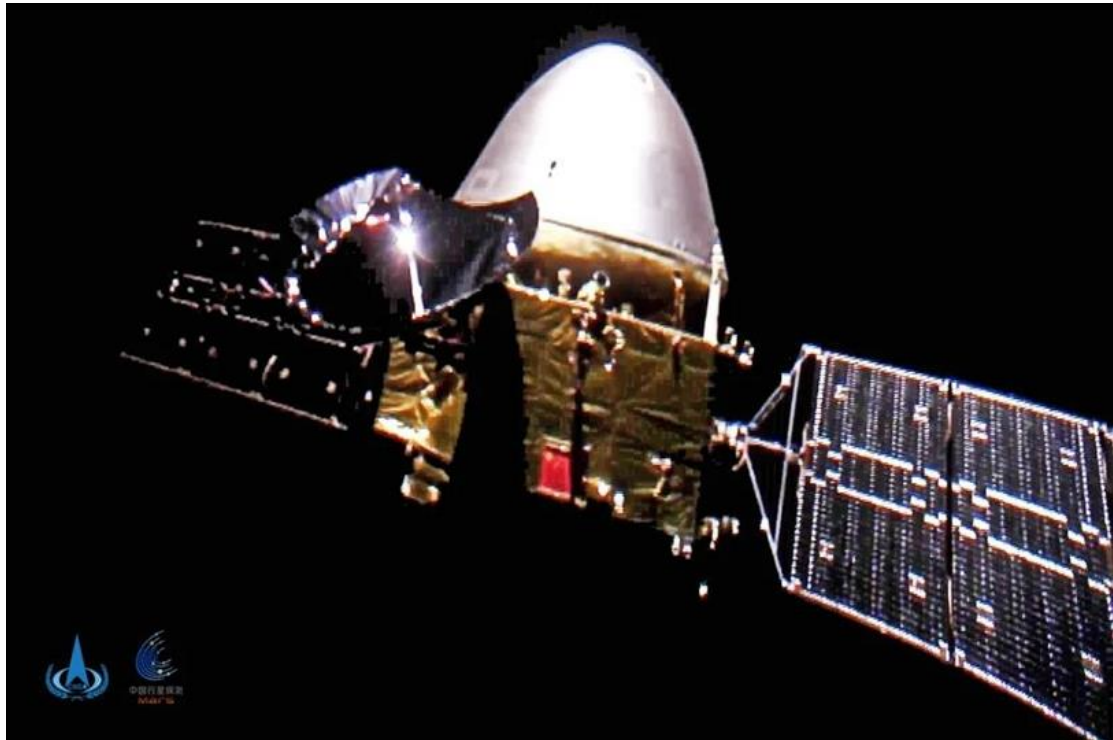


Figure 1: selfie of Tianwen-1 probe released a small camera
(2020.9.16 BJT 22:00: about 17.48 million km from Earth)

Chang'e-5 Lunar Probe

On Nov 24, China launched the Chang'e-5 spacecraft, comprising an orbiter, a lander, an ascender and a returner. Chang'e-5 was consist of 11 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, Tianma telescope has participated in the VLBI orbital determination and lunar surface positioning missions of nine flight stages, including Earth-Moon transfer, Pimilar Braking, Orbiting the Moon, Landing and Descent, Lunar Operation, Power Aascent, 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.

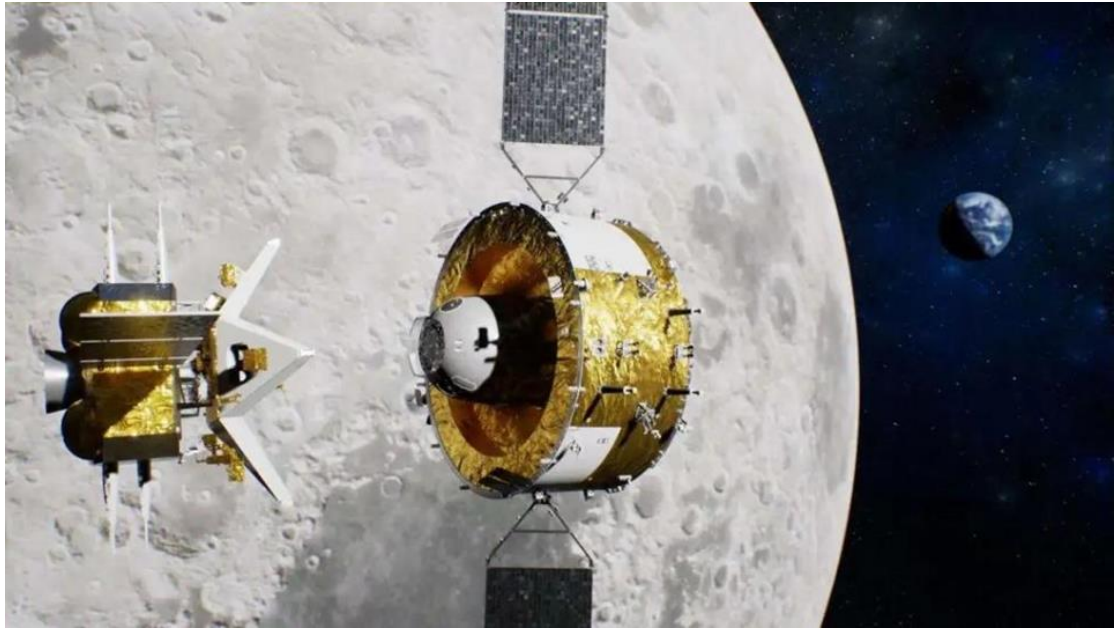


Figure 2: Chang'e-5 orbiter and ascender rendezvous and dock
(their relative positions are accurately measured using the same beam VLBI)

Prospects

For the session of 2021, Tianma 65m telescope will participate in L, C, S/X, K and Q bands observations of EVN.