URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021

Cryogenic receiving system for the Tianma telescope

Bin Li*, Zhiqiang Shen
Shanghai Astronomical Observatory, Chinese Academy of Sciences, email: bing@shao.ac.cn

The Tianma Telescope, a research facility of the Shanghai Astronomical Observatory managed by the Chinese Academy of Sciences, is a new general purpose fully steerable 65-meter diameter radio telescope to operate with high efficiency across frequency range of 1-50 GHz. Since October. 2017, the telescope has been fully opened to the international community to carry out radio astronomy observation programs.

Tianma Telescope's optical design is based on a Cassegrain configuration with a shaped 65-meter diameter primary reflector and a 6.5-meter diameter secondary reflector. The primary reflector utilizes an active surface with electromechanical actuators to compensate for the gravitational deformation and achieves a total surface accuracy of 3mm RMS during observation at high frequencies. The f/D ratio is 0.32 for the primary focus, and is 2.28 as an equivalent ratio for the secondary focus. The telescope has been designed to host 9 sets of receivers at the Cassegrain focus, including 8 on-axis positions realized by a rotatable turret and one off-axis position for the huge L-band feed horn. The Front-Ends currently installed on the Tianma Telescope include L-band (1.35-1.73 GHz), S/X-band (2.3-2.4/8.2-9 GHz), C-band (4-8 GHz), Ku-band (12-18 GHz), K-band (18-26.5 GHz), Ka-band (26-40 GHz), and Q-band (35-50 GHz). All the Front-Ends are cryogenically cooled to reduce the system noise temperature. The antenna efficiency is greater than 50% at all bands. The following stages of the receivers are a RF switch, fiber optics links between receiver cabin on telescope and observation room 120 meters away from the antenna, and common up-down converters to deliver 4 IF output signals (2 beams / 2 polarizations) for VLBI and single dish observation backends.

In this presentation, we present the architecture of Tianma's receiving system and the measured performances at each band. Tianma telescope has been playing a critical role in the international VLBI scientific research, e.g., Tianma joined the regular observations in the EVN and EAVN at L-band, S/X-band, C-band, K-band and Q-band. Depending on high sensitivity and large dynamic range at S/X-band, Tianma Telescope has made significant contributions for the spacecraft orbit determination and completed three missions successfully [1]. The three missions are Chinese Lunar Exploration Project Chang'E-4 (in 2018), Chang'E-5 (in 2020), and Chinese First Mars Exploration HX-1 (in 2020). In the coming decade, Tianma Telescope will be equipped with a suit of powerful receivers to enable broad astrophysical discovery, such as 7-beam K-band Focal Plane Array and K/Q/W triple-band receivers.

References

[1] LI B, ZHONG W Y, WANG S W, Zhang L J, LIANG S G, "S/X cryogenic receiver technology for VLBI satellite tracking," *Journal of Deep Space Exploration*, **7**, 4, August 2020, pp. 347-353, doi: :10.15982/j.issn.2095-7777.2020.20200029.