The latest progress of Five-hundred-meter Aperture Spherical radio Telescope

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After nearly two years of operation, FAST has acquired abundant scientific achievements, and more than one hundred high-quality papers have been published based on the FAST data [1–6], which have produced far-reaching scientific achievements in astronomy. Furthermore, FAST data plays an important role in constraining the physical origin of fast radio bursts. The corresponding results have been published in the journal “*Nature*”. At the same time, it is noteworthy that the total number of pulsars discovered by FAST has exceeded 500, which is a huge treasure. After a large number of observations, maybe we will further uncover the mysterious veil and look forward to the novel events we have been long expecting.

In fact, just less than two years ago we finished the commissioning of FAST. Because FAST is a giant radio telescope with a new working mode and is working in the mountainous environment and complex climatic conditions in Guizhou, a series of new technologies were urgently needed for ensuring the reliable and efficient operation of the telescope, which were discussed in detail in our previous special issue [7,8].

As for the reflector system, an innovative reflector control and safety evaluation system based on mechanics simulation technology had been developed to improve the fault tolerance of the actuators and overcome the problem of insufficient real-time feedback speed of the measurement system. As for the feed supporting system, we developed a new low-speed mode heading acquisition technology, based

on which the multi-system data fusion measurement method had been developed to solve the problem of insufficient weather resistance of optical measurement technology.

Thus, a new methodology system of telescope measurement and control method was created, adapted to the complex climate environment and special working mode of FAST. After a lot of commissioning work, the sensitivity of the telescope has exceeded 2600 m²/K, with sensitivity about 2.5 times that of the 305 m-Arecibo radio telescope.

In addition, in a special issue, Qian et al. [9] described the first pulsar discovered by FAST, which was a milestone of FAST. It was the first pulsar discovered by the radio astronomical equipment built in China. Thanks to the high sensitivity of FAST, it is possible to observe rotating radio transients (a kind of pulsars) in greater detail (Lu et al. [10]). Single-pulse studies for pulsars over an ultra-wide bandwidth could also be superior to other telescopes.

According to the latest situation, the engineering team is now committed to further improving the performance of FAST. For example, a 0.5–3.3 GHz receiver has been developed, which can greatly improve the frequency and scientific target coverage of the telescope; the developed microwave ranging system will soon replace the total station and increase the all-weather performance of the telescope. At present, the engineering team is stepping up research to develop a new generation of phased array receiver system in the next 3–5 years. The new generation of phased array receiver system can bring the telescope a large field of view and a broad band, which will greatly improve the sky survey

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efficiency of the telescope.

At last, based on the super sensitivity of FAST, we have been able to improve the time measurement accuracy of pulsars to 40–50 times better than that of other instruments. The high measurement accuracy of pulsars will not only make it possible to detect gravitational waves in China but also help us to establish a time reference system based on the pulsar time, which is a very useful supplement to our slightly lonely atomic time. If FAST is combined with active radar, it is very likely to play an irreplaceable role in the early warning of NEOs, as well as in the fields of planetary science and others.

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