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Solar Radio Observations with Meter to Decameter Wave Spectral Radio Heliograph

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The meter to decameter wave spectral radio heliograph, as one of the main instruments for Meridian II project in China, has been built to achieve the solar imaging with the capability of high-temporal, high-spectral and high-spatial resolutions. It will used for the solar physics and space weather studies by monitoring the disturbance sources produced by the solar radio activities.

The new radio heliograph operates at the frequency range from 30 MHz to 400MHz. It contains 100 steerable Log Periodic Dipole Array (LPDA) antennas, which are distributed along three spiral arms. Radio signals sensed by the antennas will be transmitted via optical fibers to indoor receivers including analog receiver and digital receiver. The receiver system processes the radio signals with a bandwidth of 100MHz and a spectral resolution of 1 MHz in every 25 milliseconds, thus it will take 100 milliseconds to cover the whole frequency band. In order to achieve good phase calibrations for the radio heliograph, a beamformed compact array including 124 LPDA antennas is employed to observe the faint radio point sources with the radio heliograph together.

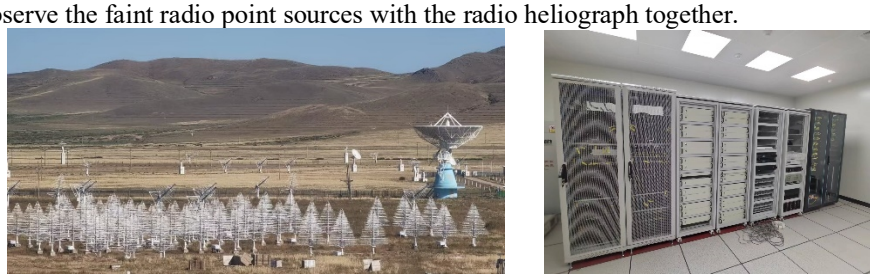

Figure 1. The antennas (left) and the indoor receivers (right) of the new radio heliograph, the compact array used for calibration is also shown at the bottom of the left panel.

In the commissioning phase, the system delay and bandpass between different antenna channels have been calibrated, and the position has also been measured and calibrated carefully for each antenna. In solar observations, several radio sources such as Cygnus A, Virgo A, Taurus A and 3C123 are observed to calibrate the array phases between different baselines. After the experimental observations for several months in 2023, the radio heliograph is capable to make the daily solar observations now.

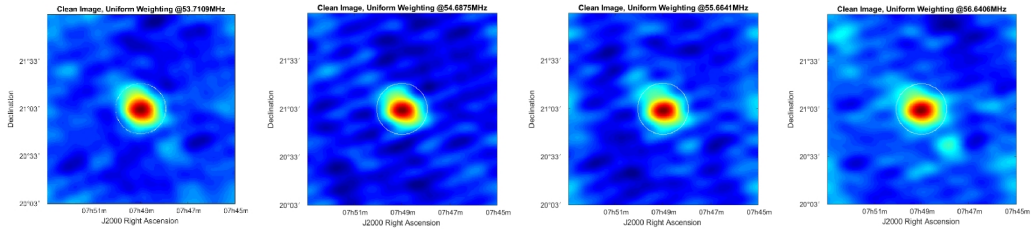

Figure 2. Solar radio imaging on Jul. 18, 2023 with the meter to decameter wave radio heliograph.

The solar imaging results show that the meter to decameter wave radio heliograph is capable to monitor and image the sun with high-temporal, high-spectral and high-spatial resolution. In future, this new radio heliograph will also be utilized to observe the celestial radio sources with the compact radio array together in night for other different scientific objectives, such as fast radio bursts, pulsar, high energy cosmic rays, etc.

1. L. Chen, Y. Yan, W. Wang, F. Liu and L. Geng, "Meter to Decameter Wave Spectral Radio Heliograph," 2020 XXXIIIrd General Assembly and Scientific Symposium of the International Union of Radio Science, Rome, Italy, 2020, pp. 1-4, doi: 10.23919/URSIGASS49373.2020.9231998.