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DESIGN OF AN ULTRA-LONG WAVELENGTH EXPERIMENTAL RADIO ARRAY

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The Ultra-Long Wavelengths (ULW) regime of longer than 10 m (frequencies below 30 MHz), remaining as the last virtually unexplored window in radio astronomy, is presently attracting more and more attentions due to some key sciences. However, the opaqueness of the Earth's ionosphere makes ULW observations below 10 MHz by terrestrial facilities practically impossible. Furthermore, the ULW spectrum is full of artificial radio frequency interference (RFI). The feasible solution for both problems is to build an ULW space-borne telescope, it is, however, very costly and challenging in both technology and engineering. Recently, studies reveal that the period post 2020 will be an appropriate opportunity to conduct systematic ground based ULW radio observations, as the night time ionospheric cut-off frequency could be well below 10 MHz [1]. In this paper we present an experimental design of ULW radio array, which operates at the frequency range from 1 to 72 MHz. This experimental array will be applied to make the radio sky observations at the ULW regime, as well as the other astronomical radio observations beyond ULW regime.

In inner Mongolia, we are operating a solar radio heliograph (MUSER), which is a solar-dedicated radio interferometric array that will be used to carry out imaging spectroscopy of the Sun, to produce high spatial resolution, high time resolution and high frequency resolution images of the Sun simultaneously. MUSER is divided into two arrays with different frequency bands, MUSER-I covering from 0.4 to 2GHz and MUSER-II operating from 2 to 15GHz. The MUSER-I contains 40 antennas of 4.5m diameter, and the MUSER-II contains 60 antennas of 2m diameter. All the 100 antennas of MUSER arrays locate on 3 log-spiral arms, and the maximum baseline length for MUSER is 3 km [2]. The signal detected by each MUSER antenna is transmitted through optic fibers to indoor devices including analogous receivers and digital receivers.

Due to the design of good expansibility for MUSER, the optical fibers for each antenna are redundant, only half of them (four fibers) are used to transmit the control signals and observation signals, the other half are still available. Therefore, we consider to use the available optical fibers to transmit the antenna signals of the ULW radio array that we plan to build. For the antenna, it should be close to the optical fiber connector which is in MUSER'S antenna base. The antennas of both MUSER arrays are forward-feed dish antenna, their feeds are supported by four struts. We design the antenna of the ULW array as a simple wire and fix it along the feed support strut, in which we can get a cross-dipole antenna by combing the four wires on the support struts. The low noise amplifier (LNA) of this antenna is fixed on the backside of the front-end box of MUSER antenna. Considering the antenna of MUSER-II array is only 2.0 m and not enough to set up a reasonable big antenna, we choose to set up the cross-dipole antenna only on the MUSER-I antenna, which allows us to have at most 40 antennas for the ULW radio array. The signals observed by the antenna will be transmitted by the fibers to an indoor digital receiver, which is employed to covert the radio frequency signals to digital signals, and perform the signal processing. Besides, a disk array is used to store all the observation data for further scientific studies.

This ULW experimental radio array will work with MUSER together simutaneously for the solar observations. It will make the ULW sky survey and observe the planetary ULW radio emissions. As a pathfinder array, It will also be used to study and demonstrate some key technologies for the furture space ULW radio array.

1. P. Janardhan, Susanta Kumar Bisoi, et al. “Solar and Interplanetary Signatures of a Maunder-like Grand Solar Minimum around the Corner - Implications to Near-Earth Space”, 2015.
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