Array Configuration Design for Chinese Spectral Radioheliograph in cm-dm wave range

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Abstract

The Chinese Spectral Radioheliograph (CSRH) will be a solar-dedicated radio interferometric array that will be optimized to carry out imaging spectroscopy of the Sun, to produce high spatial resolution (maximum 1.3”), high time resolution (<100ms) and high frequency resolution (about 1%) images of the Sun simultaneously at a wide range of frequencies. CSRH will perform coronal magnetography, detect solar atmosphere. Its science purposes include transient high-energy phenomena, coronal magnetic fields, and CME (coronal mass ejection). Imaging spectroscopy over cm-and dm-wavelength range are important for addressing fundamental problems of energy release, particle acceleration and particle transport.

The goal of radio interferometric array design for aperture synthesis in radio astronomy is to obtain the best radio imaging instrument possible for the desired range of wavelengths and resolutions, for the lowest cost of construction and operation. To obtain high quality radio imaging, an appropriate array configuration is necessary. Array configuration design must regard all possible observation situations (source positions and durations of observation), scientific purposes (single field imaging, mosaicing, astrometry, detection, …) and constraints (cost, ground composition and practicability, operation of the instrument, electromagnetic environments, …). The large number of parameters and sometimes incompatible specifications make this design problem complex and difficult to be solved globally.

This paper described some work about array configuration design for CSRH. Because of the terrains constrain of observation site (MiYun, Beijing), we have compared four array design plans - “T” configuration, “Y” configuration, irregular configuration, and spiral configuration, and without circular configuration and triangle configuration. The irregular configuration in this paper based on the algorithm presented by Boone for the ALMA and ATA in 2001. For the four configurations, we have simulated u-v data with abstract Fourier plane distribution. Base on scientific demands and engineering implement, we compared and analyzed above four configurations. For the scientific demands, we listed some performance factors for aperture synthesis arrays for every array configuration, and these factors include sidelobe level distribution, range of angular resolutions, beam sidelobe levels, optimization for deconvolution, and azimuthally symmetric. From the result of compare, we can draw a conclusion that the irregular and the spiral are better than other two configurations. For the engineering implement, we considered the difficulty of engineering and others for every array design, such as terrains constrain, electromagnetic environments, observation time, expansibility of array, and roads under the antennas. From this compare, “T”, “Y”, and the spiral are better than the irregular. Considered synthetically, we argue that the spiral geometries will be fit for CSRH.

Keywords: Radioheliograph, array configuration