Spatial Filtering of Fixed Transmitters in LOFAR

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Abstract

The Low Frequency Array (LOFAR) is an aperture synthesis telescope based on phased-array technology, and is currently under construction in The Netherlands. The roll-out of the full telescope is aimed at constructing at least 36 phased array telescope stations by 2009, spread over The Netherlands. LOFAR is the first large-scale multi-beaming radio telescope based on phased-array technology and direct sampling of antenna signals. Its operation is optimized for the frequency bands 30-80 MHz (low-band) and 120-240 MHz (high band). One low-band core station in The Netherlands and one remote telescope station in Germany are already operational, and more European countries are planning to install LOFAR phased-array stations.

The large antenna collecting area of LOFAR is achieved by a two-stage approach. In the first stage, multiple ~100 m diameter telescopes (stations) are created by phased-array beam forming of 48 low-band antennas (LBA) or 48 high-band phased-array tiles (HBA), each consisting of 16 antenna elements. The second stage combines the signals of the stations by correlating them at the central IBM BlueGene/L computer, located at The University of Groningen. Astronomical sky maps are produced by processing (Fourier transforming) the correlated data.

As LOFAR operates in bands which are also used by other services, several interference mitigation approaches will be available to LOFAR. The focus in this presentation is on theoretical considerations of spatial filtering and on experimental spatial filtering results obtained with the current LOFAR core station. This station can be partitioned into LBA and HBA micro-stations, so that both the beam forming/spatial filtering at station level and the effect of spatial filtering on correlated data can be investigated.

The wide-field calibration procedure of LOFAR poses constraints on the far side lobes of station phased-arrays. As signals from strong astronomical sources entering through far side lobes have to be removed in the calibration process, the far side lobes are not allowed to vary rapidly in time. The spatial filters at the stations are therefore limited to suppressing fixed-location transmitters. The presentation will describe the use and effectiveness of these fixed spatial filters. Both the effect of propagation and instrumental (in)stability on the spatial filter effectiveness will be considered.