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First Colombian Solar Radio Interferometer: current stage

J. C. Guevara Gómez[1], J. C. Martínez Oliveros[2] and B. Calvo-Mozo[1]

[1]Observatorio Astronómico Nacional, Universidad Nacional de Colombia
Ciudad Universitaria, Bogotá, Colombia
email: `jcguevarag@unal.edu.co`

[2]Space Sciences Laboratory, University of California Berkeley
94720 CA, 7 Gauss Way, USA
email: `oliveros@ssl.berkeley.edu`

[1]Observatorio Astronómico Nacional, Universidad Nacional de Colombia
Ciudad Universitaria, Bogotá, Colombia
email: `bcalvom@unal.edu.co`

Abstract. Solar radio astronomy is a fast developing research field in Colombia. Here, we present the scientific goals, specifications and current state of the *First Colombian Solar Radio Interferometer* consisting of two log-periodic antennas covering a frequency bandwidth op to 800 MHz. We describe the importance and benefits of its development to the radioastronomy in Latin America and its impact on the scientific community and general public.

Keywords. Radioastronomy, Interferometry, Solar Physics

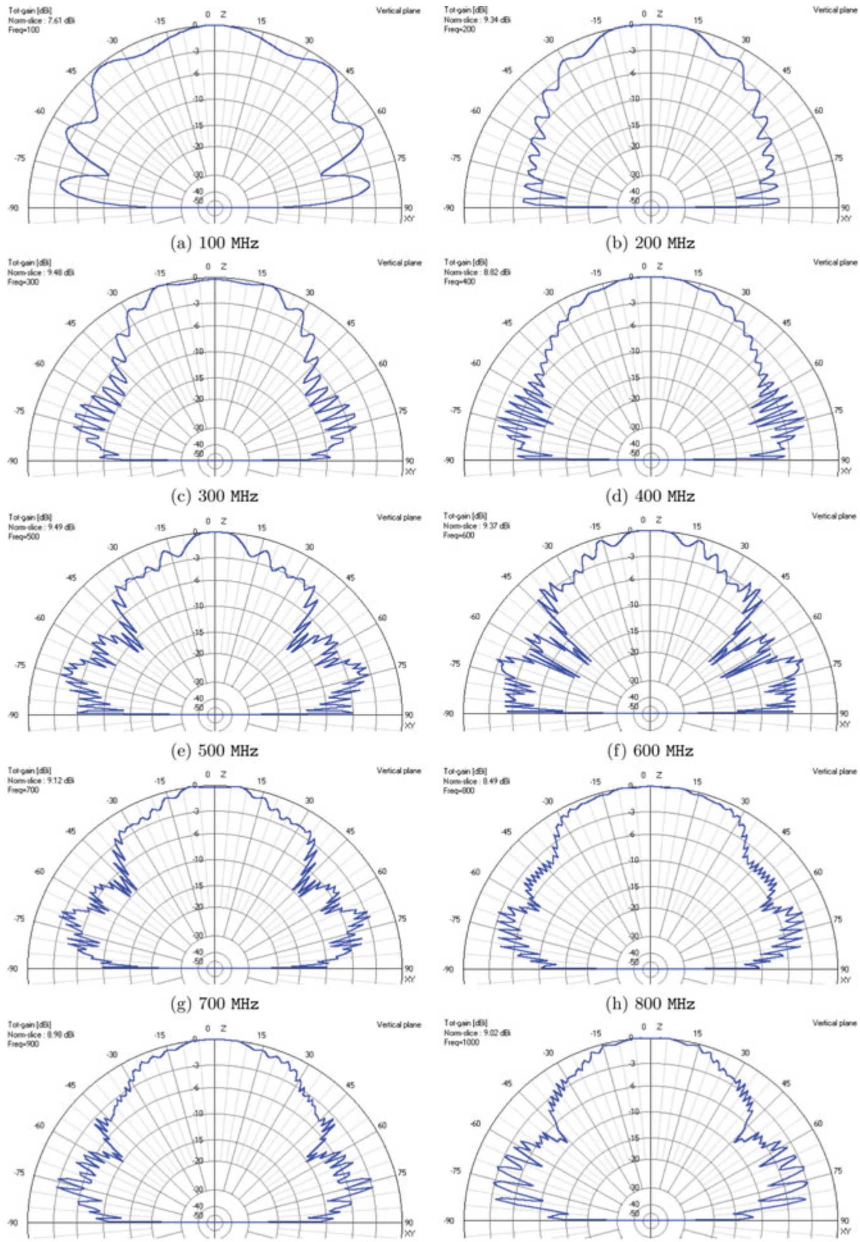
1. Introduction

Colombia is a country located in the northern tip of South America close to the Amazon Rainforest and therefore in the Intertropical Convergence Zone (ITCZ). This last fact makes astronomical observations with optical instruments challenging, as cloud coverage is relatively high during the year. Hence, radio astronomy becomes a natural choice for the development of the astronomy, astrophysics and astronomical instrumentation. Consequently, a broadband radio interferometer is being designed and built at the Observatorio Astronómico Nacional – Universidad Nacional de Colombia. *The First Colombian Solar Radio Interferometer* (FiCoRI) has a frequency bandwidth up to 800 MHz. In this work we give a brief description of the main characteristics of FiCoRI, as well as, its current development state.

2. FiCoRI: Specifications and Goals

FiCoRI is a solar dedicated radio interferometer for continuous observations between the ionospheric cutoff frequency and 800 MHz using two directional log-periodic broadband antennas, scalable to more elements if desired. One of the main features of FiCoRI is that the spectral and time resolution are adjustable according to the observer necessities. This allows us to sacrifice the time resolution for the spectral resolution and viceversa, making the instrument flexible and with minor adaptation able to observe planetary, galactic and extra-galactic radio sources.

For solar physics, FiCoRI is expected to *i)* contribute to the study of the particle acceleration during solar flares; *ii)* the position, time and frequency evolution of radio



(a) 100 MHz (b) 200 MHz (c) 300 MHz (d) 400 MHz (e) 500 MHz (f) 600 MHz (g) 700 MHz (h) 800 MHz (i) 900 MHz (j) 1000 MHz

Figure 1. LPDA Radiation Pattern from 100 MHz to 1000 MHz.

sources associated with Coronal Mass Ejections (CMEs); *iii)* to study solar radio bursts and their association to space weather, and *iv)* FiCoRI serve as an educational tool to teach of radio astronomy and radio astronomical techniques to undergraduate and graduate students.

2.1. *The antennas and the acquisition data system*

Because of our requirements, broad bandwidth and antenna directivity to point in the direction of a source (the Sun), the log-periodic dipole array antenna (LPDA) was selected.

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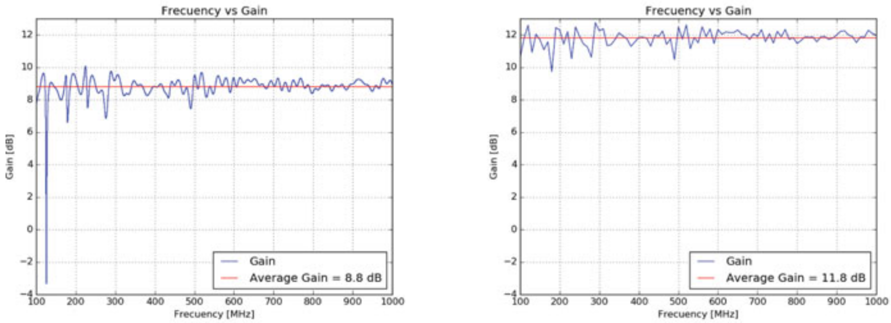

(a) Gain for one LPDA. (b) Gain for two LPDA as interferometer.

Figure 2.

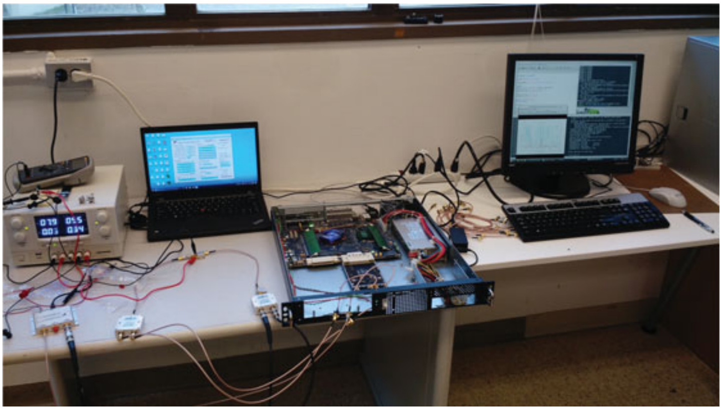

Figure 3. ROACH device with pre-amplification system.

The LPDA consists of a number of dipoles connected in such a way that the whole set makes an antenna with a broad bandwidth in which the electrical characteristics remains constant (Milligan 2005).

Figure 1 shows the LPDA radiation patterns from 100 MHz to 1000 MHz in 100 MHz steps. It is clear that the main lobes are well defined and vary slightly with frequency. Because each pattern is normalized to 0 dB and taking into account that a decrease in 3 dB means a decrease in the half of the power, the antenna can be considered directional and therefore it is possible to say that the gain is equal in every single frequency.

When two LPDA are set as an interferometric array with a separation distance between the antennas of $10\lambda_{max}$ is found that the gain of the instrument grow up in 3 dB, i.e., the interferometer is able to detect signals with a half of the power than only one antenna was, see figure 2.

The acquisition data system, is basically composed by the pre-amplifier electronics, analog digital converter and the electronics to make the signal processing. FiCoRi uses a ROACH FPGA system from the CASPER Group at the University of California Berkeley (see `https://casper.berkeley.edu/`) as the main processing and digitization device.

2.2. *Current Stage*

Tests with one antenna are being carrying currently. Figure 3 shows the testing unit composed of the pre-amplifier electronics and ROACH device working. Figure 4 shows a dynamic spectrum taken from December 20 until December 22 covering frequencies up

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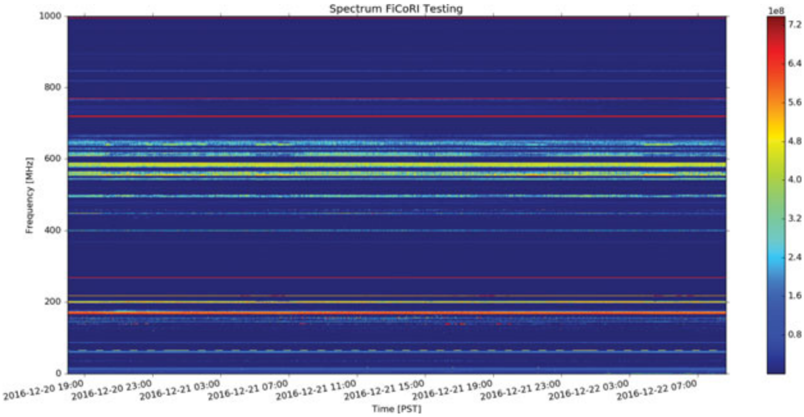

Figure 4. Dynamic spectrum up to 1000 MHz. FiCoRi Testing.

to 1000 MHz, no power or intensity calibration has been performed and therefore the power is in arbitrary units. The spectral resolution is 2 MHz and the time resolution is 10 s. From the initial testing it is clear that we can observe and distinguish individual TV channels, air traffic control bands, among others. A filtering unit has been added to the preamplifier chain to eliminate the FM signals from the spectra. The next step in our development is the implementation and testing of the correlator, as well as, the calibration of the antennas with known sources to be provide radio spectra in physical quantities.

Reference

Milligan, T. A. 2005, Modern Antenna Design, *IEEE press and Jhon Wiley and sons*

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