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The Mexican Array Radio Telescope (MEXART). An Interplanetary Scintillation Array in Mexico in the IHY

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Abstract: The Mexican Array Radio Telescope (MEXART) consist of a 64x64 (4096) full wavelength dipole antenna array, operating at 139.65 MHz, occupying 9,591 square meters (139m along the East-West direction x 69m along the North-South direction) to carry out interplanetary scintillation (IPS) observations of solar wind disturbances. This is a transit dedicated radio array for IPS measurents in the state of Michoacan (380 km North-West from Mexico City, Lat. 19° 48' N, Long. 101° 41' W and 1964m above sea level). The aim of this instrument is to daily scan the sky at 140 MHz in order to track large-scale solar wind disturbances propagating between the Sun and the Earth using the Interplanetary Scintillation (IPS) technique. We report the final system testings, galactic and extragalactic radio source transits, and the collaboration plans for the International Heliophysical Year.

Introduction

The phenomenon called Interplanetary Scintillation (IPS) is the random intensity variation of a cosmic radio source of small diameter (¡2 arcsec) caused by the diffraction of the wave front as it propagates through random fluctuations in the refractive index of the turbulent interplanetary medium. These phase distortions of the radio wave front are related to the small scale electron density inhomogeneities (Δn_e) in the interplanetary plasma that produce a diffraction pattern in the plane of the observer and create intensity fluctuations (scintillations) as the diffraction pattern is convected across the antenna by the solar wind [1].

The IPS technique assumes that these electron density fluctuations (Δn_e) are proportional to density variations in the solar wind. The increments in solar wind density and related IPS events may be associated with two general types of solar wind disturbances: (1) the region around a stream interface between a fast solar wind stream overtaking a slow ambient wind (corotating interaction regions) and (2) the density enhancement associated with solar transient events such as ICMEs or other solar activity. Therefore we can use IPS observations to identify large- scale solar wind perturbations propagating from the Sun to 1 AU [2]. The IPS provides information on the large-scale shape and velocity of solar wind disturbances within a range in the interplanetary medium where no other technique is capable to do it.

In 2001 we began the construction of an IPS array in Mexico operating at 139.65 MHz called Mexican Array Radio Telescope (MEXART). Details of the antenna array, amplification and combination systems, and receiver can be found in [3]. The array has 64 parallel E-W rows and each row has 64 dipoles. Every E-W row can be considered as a uniform linear array of 64 elements with the same

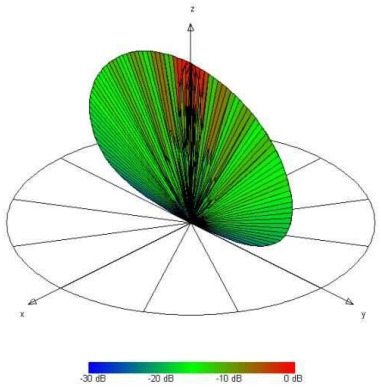

Figure 1: Power pattern of a 64-dipoles array along the two main directions (E-W and N-S).

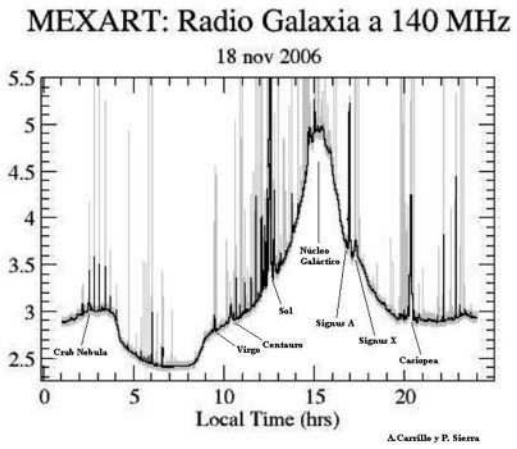

Figure 2: The trace of galaxy at 140 MHz as detected by MEXART on 18-Nov-2006.

amplitude and phase having a length of 64 λ. In total the array has 64 x 64 = 4096 elements occupying (69m x 139m) 9,591 square meters.

In 2005-2006 we accomplished the construction of the array and we initiated the calibration testings of the antenna pattern. Using a 64 dipoles E-W row in a full power configuration (Figure 1) we measured transits of the Sun (with different E-W rows [4]) and strong cosmic radio sources [5]. From these First testings we realized some problems such as: a bad coupling of electric impedances between the baluns and the dipoles-transmission lines and fails in the amplifiers that were causing a loss of signal and phase changing. After correcting these problems, we improved the response of the system by implementing band pass filters at the first and second levels of amplification, and we implemented the web server (http://www.mexart.unam.mx) to present the MEXART data in real time.

Galactic observations at 140 MHz and real time server

The MEXART is a transit instrument that detects the passing of cosmic radio sources at 140 MHz. We record on daily basis the trace of the galaxy through the main beam. Figure 2 shows an example of this observations with the transit of the Galaxy in November 2006. The plot shows the transit of Crab Nebula, Virgo, Centaurus, Galactic Nucleus, Cygnus A, Cygnus X, Cassiopeia, and the Sun. This daily scan is reported on real time at the Observatory website.

One of the activities that we organized in Mexico for the celebration of the International Heliophsyical Year (IHY) was the the Virtual Earth-Sun Observatory (VESO). The VESO is located at the website www.veso.unam.mx, showing a real time integrated data-base obtained from four instruments of the Instituto de Geofisica-UNAM studying Sun-Earth connection phenomena, these are: (1) a Solar Radio Interferometer (RIS)measuring the lower solar atmosphere radiation at 7.5 GHz, revealing microwave bursts associated with solar activity; (2) the MEXART; (3) the Cosmic Ray Observatory detects high energy galactic particles (more than 8.2GeV); and (4) the Teoloyucan Geomagnetic Observatory which measures continuously the three components of the field an is capable of monitoring disturbances affecting the Earth's field. Figure 3 shows an example of a VESO observation on 17-February-2007. The MEXART plot shows the transit of Virgo, Centaurus, Galactic Nucleus, Cygnus A and Cygnus X.

SUMMARY

We report the advances in the calibration of the MEXART antenna and the initial observations of

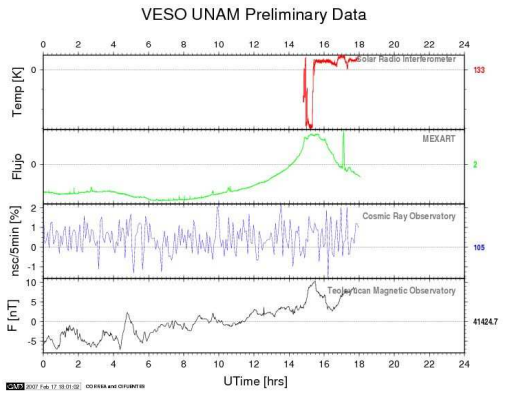

Figure 3: Virtual Earth-Sun Observatory (VESO) real time measurements on 17-Feb-2007.

strong radio sources. The MEXART is showing data in real time and the response has been improved significantly. The VESO instruments provide data from four different points of the complex chain of the solar terrestrial relations and will allow the study of intense solar events in radio and its interplanetary and geomagnetic consequences.

Acknowledgements

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References

[1] S. Ananthakrishnan, W. A. Coles, J. J. Kaufman, Microturbulence in solar wind streamsmicroturbulence in solar wind streams, Journal of Geophysical Research 85 (1980) 6025–6030.

[2] A. Hewish, S. Bravo, The sources of large-scale heliospheric disturbances, Solar Physics 106 (1986) 185–200.

[3] J. A. González-Esparza, A. Carrillo, R. Andrade E., Pérez-Enríquez, S. Kurtz, The mexart interplanetary scintillation array in mexcio, Geofísica Internacional 43 (2004) 61–73.

[4] A. González-Esparza, A. Carrillo, E. Andrade, R. Perez-Enriquez, S. Kurtz, X. Blanco-Cano, Callibration testings of the mexart antenna using the solar transit, Advances in Space Research.

[5] J. A. González-Esparza, E. Andrade, A. Carrillo, et al., Mexart measurements of radio sources, in: ESA SP-592: Solar Wind 11/SOHO 16, Connecting Sun and Heliosphere, Vol. 592 of ESA Special Publication, 2005.
URL `http://adsabs.harvard.edu/cgi-bin/nph-bib`$_{query?bibcode} = 2005soho...16E.132Gdb_{key} = AST$