MEXART MEASUREMENTS OF RADIO SOURCES

A. González-Esparza[1], E. Andrade[1], A. Carrillo[1], S. Jeyakumar[1], S. Ananthakrishnan[2], A. Praveenkumar[2], G. Sankarasubramanian[2], S. Sureshkumar[2], P. Sierra[3], S. Vazquez[3], R. Perez-Enriquez[4], and S. Kurtz[5]

[1]Instituto de Geofisica, UNAM, Mexico
[2]National Centre for Radio Astrophysics, TIFR, India
[3]Instituto de Geofisica y Astronomia, CITMA, Cuba
[4]Centro de Geociencias, UNAM, Mexico
[5]Centro de Radioastronomia y Astrofisica, UNAM, Mexico

ABSTRACT

The Mexican Array Radio Telescope (MEXART) consists of a 64x64 array of full-wave dipoles operating at 139.65 MHz. The primary aim of the array is to perform Interplanetary Scintillations (IPS) observations of radio sources to track large-scale solar wind perturbations within 1 AU. We describe the initial measurements of radio sources and the advances in the calibration of the antenna.

Key words: Interplanetary Scintillation, Instruments and Techniques, Space Weather.

1. INTRODUCTION

In general, Interplanetary Scintillations (IPS) events are associated with increments in solar wind density (ΔN_e) related to two general types of large-scale solar wind disturbances: (1) the region around a stream interface between a fast solar wind stream overtaking a slow stream (corotating interaction region) and (2) the density enhancement associated with solar transient events such as ICMEs and interplanetary shocks (Hewish and Bravo, 1986). IPS observations provide information on the large-scale shape and velocity of solar wind disturbances within a range in the interplanetary medium where no other technique is available to do it (Manoharan et al., 2001).

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 Gonzalez-Esparza et al. (2004) (hereafter paper 1). The array has 64 parallel

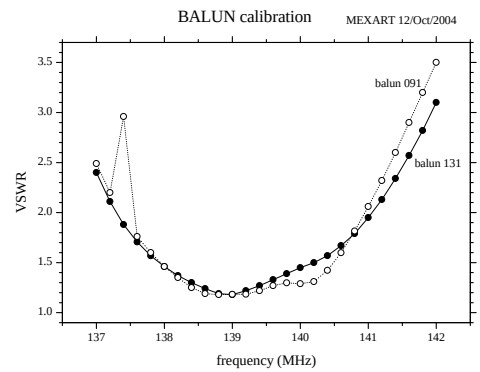

Figure 1. Calibration of the baluns. Voltage stationary wave ratio (VSWR) measurements showing the tunning of the baluns around the operation frequency of the MEXART (139.65 MHz).

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 amplitude and phase having a length of 64 λ. The operation of the radio telescope requires that the signals coming from all the E-W rows arrive at the back-end with the same phase ($\pm 1°$) and amplitude (± 1 dB). In total the array has 64 x 64 = 4096 elements occupying (69m x 139m) 9,591 square meters.

We initiated the calibration tests of the antenna pattern by measuring solar transits with different E-W rows (Gonzalez-Esparza et al., 2005) (hereafter paper 2). The testing showed similar patterns of the main and the two minor lobes for all the E-W rows, but there were gain differences and some extra minor lobes related to problems with the coupling of the transmission lines and the baluns, and differences in the amplification gains causing that the beam patterns were not symmetric. We addressed these

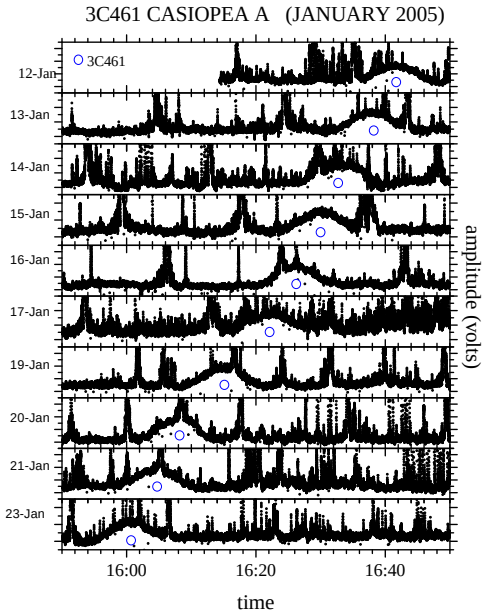

Figure 2. Cassiopeia A (3C461) transit measurements during January 2005 using a single E-W row (64 dipoles).

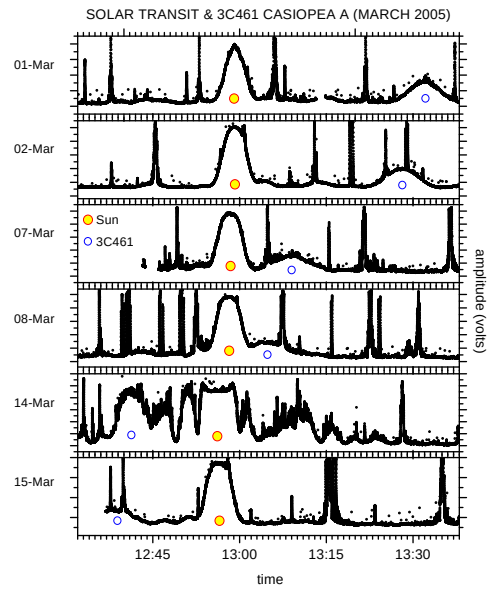

Figure 3. Solar and Cassiopeia A (3C461) transit measurements during March 2005 using a single E-W row (64 dipoles).

problems improving the performance of the system. We present the initial observations of strong radio sources and the advances in the calibration of the antenna, where we describe briefly the corrections made on the antenna system and receiver.

1.1. Balun Calibration

The antenna requires that input and output terminals of the preamplifiers being balanced. The system must thus be detuned for currents on the outside of the line through a Balanced to Unbalanced Transformer (BALUM) device. We had a problem with the baluns, a bad coupling of electric impedances between the baluns and the dipoles-transmission lines was causing a loss of signal and phase changing. The series of minor lobes shown in Figure 4 in paper 2 were related to this problem. After correcting this mistake we performed several test on the baluns response. Figure 1 shows the VSWR measurements of two baluns to different frequencies showing the very good tunning around 139.65 MHz.

1.2. Receiver

The MEXART receiver is of the Dicke type and is described in paper 1. We found that there were some problems with the active filters (low band pass) causing a poor performance of the video card. We replaced the filter and the gain amplifier improving the performance of the video card. We also implement a pre-select bandpass filter at the input of the receiver. This band pass filter has 6 MHz of bandwidth around the operation frequency.

2. OBSERVATIONS

The first step in the calibration is to detect the transit of strong radio sources. From the end of 2004 we have been tracking on day to day basis the transit of some of the sources. Figure 2 shows the transit of 3C461 (Cassiopeia A) during the beginning of 2005. The plots show the characteristic delay of about 4 minutes between consecutive days. The are strong RFI signals. Some of these interferences were produced by the problems at the receiver described above.

Figure 3 shows the observations of the transit of the Sun and Cassiopeia in 2005. The solar transit occurs at about the same time every day, but Cassiopeia shows the typical temporal displacement of the cosmic radio sources. On March, 14th, the two sources saturated the receiver. Comparing with the observations of the previous figure we notice that the RFI signals reduced after changing the active filter in the receiver.

Figure 4 shows transit observations of 3C405. In this case we used different combinations of E-W rows (R in the label of the figure) to test the phase and gain of the E-W rows.

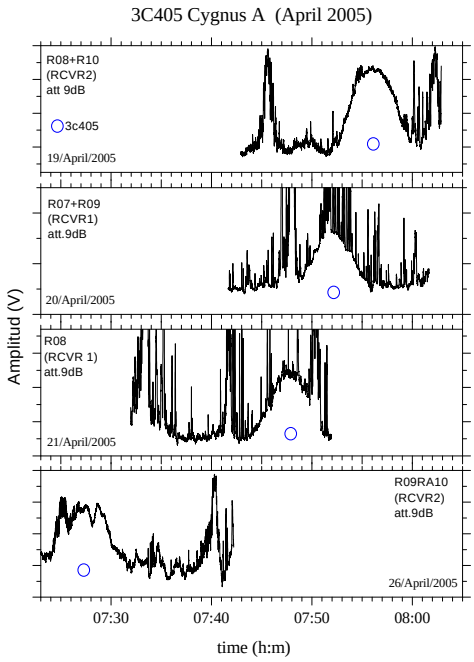

Figure 4. Cygnus (3C405) transit measurements during April 2005 using different combinations of two E-W rows (R) and receivers (RCVR).

3. SUMMARY

We report the advances in the calibration of the MEXART antenna and the initial observations of strong radio sources. The system requires an improvement in the temperature of the receiver and a reduction of the bandwidth in the bandpass filter to improve the sensitivity of the system. These modifications are under way and will be reported elsewhere.

ACKNOWLEDGMENTS

We are grateful to Max Mendizabal for providing the software with the catalog of the radio sources at MEXART and Gilberto Casillas for his support in the computing network. This project was partially supported by DGAPA project IN-111602 and CONACYT project 36917.

REFERENCES

Gonzalez-Esparza A.,Carrillo A., Andrade E., R. Perez-Enriquez, S. Kurtz, 2004, Geofisica Internacional, 43, 61

Gonzalez-Esparza A., Carrillo A., Andrade E., Sierra P., Vazquez S., Rodriguez C., Perez-Enriquez R., Kurtz S., Blanco-Cano X., 2005, Adv. Space Res., in press.

Hewish A., Bravo S., 1986, Solar Phys., 106, 185

Manoharan P. K., Tokumaru M., Pick M., Subramanian P., Ipavich F. M., Schenk K., Kaiser M. L., Lepping R. P., Vourlidas A., 2001, 559, 1180