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# Brazilian Decimetre Array (Phase-1): Initial solar observations

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**Abstract**

An East–West one-dimensional radio interferometer array consisting of 5 parabolic dish antennas has been set-up at Cachoeira Paulista, Brazil (Longitude: 45°0′20″W, Latitude: 22°41′19″S) for observations of Sun and some of the strong sidereal sources by the Instituto Nacional de Pesquisas Espaciais (INPE), Brazil. This is Phase-1 of the proposed Brazilian Decimetre Array (BDA) and can be operated at any frequency in the range 1.2–1.7 GHz. The instrument is functional since November 2004 onwards at 1.6 GHz. The angular and temporal resolution at the above frequency range are ~3′ and 100 ms, respectively. We present here the initial solar observations carried out with this array.


*Keywords:* Radio interferometer; Decimeter frequency range; Solar observations

## 1. Introduction

Observations of radio emission from Sun have contributed significantly to the understanding of fundamental problems in solar physics over the last several decades (Pick et al., 1990; Bastian et al., 1998 and the references therein). Emission from the Sun is observed over almost the entire radio window of the electromagnetic spectrum. Observations in the decimetre wavelength range in particular play an important role since solar radio emission observed in the above band is considered to originate close to the region from where particle acceleration and energy release occurs during a solar flare (Tanuma and Shibata, 2005; Barta and Karlický, 2005). The flare related radio emission in this range includes a wide variety of plasma emission processes and is a useful tool for probing the associated energy release and electron acceleration (Bastian et al., 1998 and the references therein). Over the last several years, radio spectrograph observations in the decimetre band have provided a wealth of data on different solar transients (Aschwanden, 2004; Benz, 2004 and the references therein). However, their location in the solar atmosphere is yet to be established. In view of the above and due to the absence of a facility for dedicated radio imaging observations of Sun in the southern hemisphere, particularly to the west of Greenwich, the scientists and engineers of INPE, Brazil are now in the process of constructing a radioheliograph that can operate in the frequency range 1.2–5.6 GHz (Sawant et al., 2000a,b, 2002, 2003, 2006). Figs. 1 and 2 show a view of BDA Phase-1 and the array configuration, respectively.

## 2. Observations

As a part of our first observational program, we carried out observations of Sun during November–December,

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Fig. 1. Phase-1 of the BDA at INPE campus in Cachoeira Paulista (Longitude: 45°0′20″W, Latitude 22°41′19″S). The array is in the E–W direction and the longest baseline length is 216 m. The antenna (A5) in the near side is the East end of the array.

2004. The observing frequency was 1.6 GHz. Fig. 3 shows the variation in peak brightness temperature ($T_b$) of the Sun around local noon, during the above period. The average value was about $1.56 \times 10^5$ K. The sidereal radio sources Taurus A (3C144) and Cygnus A (3C405) were used to calibrate the observed visibilities. Details of calibration and image synthesis are given by Sawant et al. (2006). Fig. 4 shows the peak $T_b$ observed particularly on December 8, 2004 at different epochs during the interval 12–18 UT. One can notice that there is a steady increase starting from 14 UT. Fig. 5 shows the one-dimensional brightness distribution obtained with BDA around 15:00 UT, on that day. According to the Solar Geophysical Data reports (http://sgd.ngdc.noaa.gov/sgd/), there was a SF/C2.5 class H-α/GOES flare on December 8, 2004 from NOAA/USAF AR 10709 (N05 W03) during the interval 19:34–20:44 UT. The peak of the event was around 19:59 UT. There was also a H-alpha filament disappearance from the location (N01 W07) in the interval 19:17–19:42 UT. The LASCO instrument onboard SOHO reported a CME around the same period on that day. The first height-time measurement of the event was around 20:54 UT, at a radial distance of about 2.46 $R_s$ in the LASCO C2 field of view (http://cdaw.gsfc.nasa.gov). No outstanding radio emission was reported from elsewhere (http://sgd.ngdc.noaa.gov/sgd/).

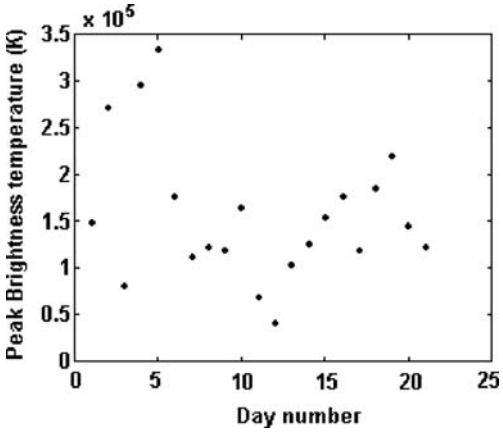


Fig. 3. Day-to-day variation in the peak $T_b$ of Sun observed with BDA at 1.6 GHz during the local noon of November–December 2004.

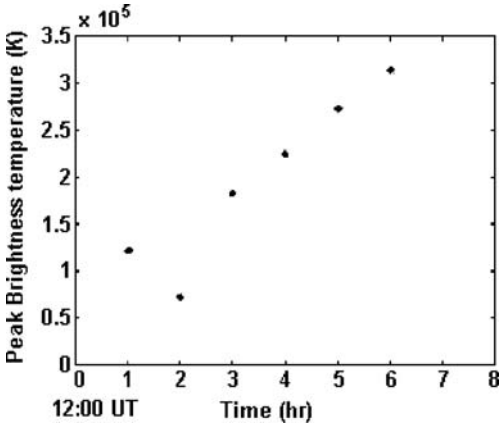


Fig. 4. Hourly variation in the peak $T_b$ of Sun observed with BDA at 1.6 GHz on December 8, 2004 during the interval 13–18 UT.

## 3. Conclusions

We have presented preliminary solar observations carried out with Phase-1 of the Brazilian Decimetre Array during November–December 2004 at 1.6 GHz, in this paper. Our data indicates:

(1) The day-to-day variation in the peak $T_b$ of the radio emission from Sun during local noon is in the range $0.5–3.5 \times 10^5$ K. These values are consistent with those reported in the literature (Dulk and Gary, 1983).

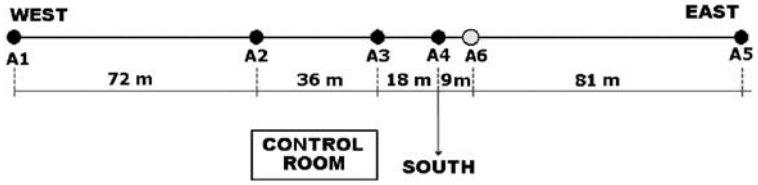


Fig. 2. Array configuration of BDA Phase-1. The open circle shows the location of the 6th antenna that is presently under installation. This will improve the low spatial frequency coverage of the array. The number of baselines will increase to 15 with the commissioning of the 6th antenna.

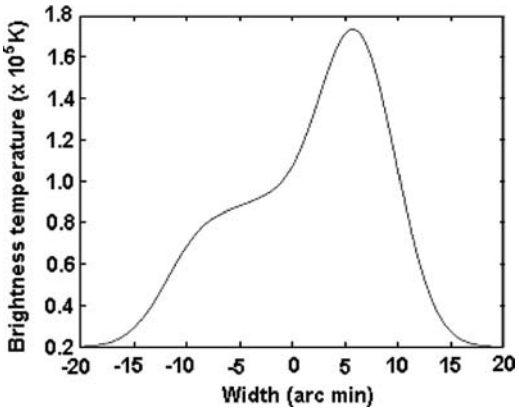


Fig. 5. East–West one-dimensional brightness distribution of the Sun obtained with BDA on December 08, 2004 around 15:00 UT. Solar east is to the left.

(2) There is a steady increase in the peak $T_b$ over a period of about 5 h, prior to the filament disappearance and impulsive phase of the flare of December 8, 2004. It is possible that the $T_b$ increase observed by us could be due to either filament activity prior to its eruption or pre-flare heating or a combination of both (Fárník et al., 2003). A detailed investigation of the above observations is in progress and shall be published separately.

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