Callisto spectrum measurements in Gauribidanur

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Callisto spectrum measurements in Gauribidanur

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Abstract. During a measurement campaign in winter 2006 spectrum measurements were done at different locations in India. This report describes the results at Gauribidanur radio telescope site. Measurements were done with a broadband logarithmic periodic antenna of the site connected to a Callisto spectrometer designed and built by ETH Zurich (Benz, 2004). This measurement campaign shall be the technical basis to decide how to continue concerning spectroscopic measurements below 1GHz with existing antennas and/or new ones. The results are presented, compared with Switzerland and discussed in form of digitally zoomed spectrums in the most interesting radio astronomy frequency ranges.

Key words. Callisto, spectrum, cross modulation, interference.

1. Introduction

In view of IHY and also in view of an intention to upgrade Gauribidanur station, a measurement campaign was planned and organized between IIA Bangalaore and ETH Zurich. The measurement took place after the IHY meeting in Bangalore between Dec. 3th and Dec. 4th 2006 at the Gauribidanur observatory in India.

1.1. Station description

The Indian Institute of Astrophysics in a joint collaboration programme with the Raman Research Institute operates a radio observatory located at Gauribidanur about 100 km north of Bangalore. Commissioned in 1976, the various facilities at the observatory are actively used to study radio emission from the sun, pulsars, supernova remnants, galactic and extra-galactic sources. The Indian Institute of Astrophysics in a joint collaboration programme with the Raman Research Institute operates a radio observatory located at Gauribidanur about 100 km north of Bangalore, India. For geographical coordinates see table 1.

1.2. Measurement instrumentation

We used on of the logarithmic periodic antenna of the telescope site connected via a preamplifier and a low loss coaxial cable to the observatory. The Callisto spectrometer e-C03 having a detector sensitivity of 25mV/\text{dB} including control cables and rf adapters was supplied by ETH Zurich. The channel resolution is 62.5KHz, while the radiometric bandwidth is about 300KHz. The sampling time is in the order of 1.25msec per frequency-pixel. The frequency is expressed in MHz and the detector out-
2 Chr. Monstein, R. Ramesh: Gauribidanur spectrum analysis

Fig. 2. V. C. Kathiravan sitting in front of the CALLISTO spectrometer (small box bottom left of the flat screen).

Table 1. Geographical coordinates of Gauribidanur telescope site.

<table>
<thead>
<tr>
<th>Coordinate value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude 13° 36' 12&quot;</td>
</tr>
<tr>
<td>Longitude 77° 26' 07&quot; East</td>
</tr>
<tr>
<td>Height xxx m asl</td>
</tr>
<tr>
<td>Local Time GMT + 05h 30min</td>
</tr>
</tbody>
</table>

Table 2. Acronyms mentioned in labels and comments.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Callisto</td>
<td>Radiospectrometer</td>
</tr>
<tr>
<td>CRAF</td>
<td>Committee on Radio Astronomy Freq.</td>
</tr>
<tr>
<td>DVB-T</td>
<td>Digital video broadcast terrestrial</td>
</tr>
<tr>
<td>ETH</td>
<td>Eidgenössisch Technische Hochschule</td>
</tr>
<tr>
<td>FM</td>
<td>Frequency modulation (Radio)</td>
</tr>
<tr>
<td>IIA</td>
<td>Indian Institute of Astrophysics</td>
</tr>
<tr>
<td>rf</td>
<td>radio-frequency</td>
</tr>
<tr>
<td>RISC</td>
<td>Reduced Instruction Set Computer</td>
</tr>
<tr>
<td>SWR</td>
<td>standing wave ratio</td>
</tr>
<tr>
<td>TV</td>
<td>Television</td>
</tr>
<tr>
<td>UHF</td>
<td>ultra high frequency</td>
</tr>
</tbody>
</table>

1.3. Acronyms

Different acronyms used in labels and text are described in table 2.

put is expressed in milli volts. Both are stored in a simple ASCII file which can be analyzed with any spreadsheet like IDL or EXCEL.

2. Results

2.1. Comparative overview Gauribidanur/India versus Zurich/Switzerland

The measured spectrum was split into 7 sub spectra to better give comments on it. For plots, see figures 3, 4, 5, 6, 7, 8 and 9. The total spectrum is composed of 13200 channels 62.5KHz apart. In all plots shown below 0dB is referenced to the background noise level given by a 50Ω termination resistor at ambient temperature of about 20°C.

2.2. Observation of a bright flare with CALLISTO

Occasionally the sun was very active a few days after installation and configuration. Thus, during that time a couple of flares were recorded with Callisto. A very bright one was NOAA-event number 3650 on December 10th at 07:27:40, see figure 10. The radio flare seems to be mir-
Fig. 5. Spectral overview measured in Gauribidanur and Zurich observatory. Gauribidanur noise level is about 20dB higher than in Switzerland due to preamplifier. 245MHz itself is free of interference in Gauribidanur. The frequency 245MHz is a fixed frequency for the measurement of quiet sun flux but shared with other services.

Fig. 6. Spectral overview measured in Gauribidanur and Zurich observatory. Near 324MHz small carrier of unknown source. The range 322MHz until 328.6MHz is reserved for line observations. Primary use for radio astronomy.

Fig. 7. Spectral overview measured in Gauribidanur and Zurich observatory. Comparable low interference level in both countries. Higher noise level in Gauribidanur is due to preamplifier. The range 406.1MHz until 410.0MHz is reserved for radio astronomy services. Primary use for radio astronomy.

Fig. 8. Spectral overview measured in Gauribidanur and Zurich observatory. Comparable low interference between these two countries. Higher noise level in Gauribidanur is due to preamplifier. The range 608.0MHz until 614.0MHz is a non-exclusive band reserved radio astronomy services.

Fig. 9. Spectral overview measured in Gauribidanur and Zurich observatory showing UHF TV band. In Switzerland (blue plot) the range between 550MHz and 575MHz is used by DVB-T and thus no frequency can be use for observation. In Gauribidanur (red plot) there is no single analog TV channel thus, the whole range can be used for radio astronomy.

3. Conclusions

Gauribidanur is not yet suffering from DBV-T and other broad band applications and is thus, an ideal place for a solar frequency agile spectrometer. All reserved frequencies are still free from interference. Most of the strong interferences are home made by local electronic devices and local oscillators. To mitigate self induced interferences we strongly recommend not to remote switch antennas electronically. But when needed then low pass filters and shielded cables should be used. Whenever possible, feed all coaxial cables down to the receivers. As soon as one...
wants to install a second system which is not frequency- and phase locked to the main receiving system it will suffer from electromagnetic interference from the neighboring system. One should try to shield all local oscillator components and also all IF components to prevent leakage of rf into the receiving antenna of CALLISTO. It is strongly recommended to move the logarithmic periodic antennas as far away as possible from the institute to reduce local interferences. It might be useful to upgrade the antenna mount for automatic tracking of the sun. This would allow to get the same sensitivity for the whole time of daily observation of the sun.

4. Relevant internet addresses

4.1. CRAF
http://www.craf.eu

4.2. Callisto

4.3. IHY
http://ihy2007.org/

4.4. X-flare
http://www.sec.noaa.gov/ftpdir/indices/events/20061210events.txt

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References