Callisto spectrum measurements at Birr Castle, Ireland

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Draft 30.06.2009 / Updated 30.06.2009

Abstract. This report documents part of a planned measurement campaign in which spectrum measurements were done at different locations worldwide. The results of the Birr castle observatory site in Ireland, which was studied at the end of June 2009, are presented. Measurements were carried out with a commercial DVB-T antenna connected to a Callisto spectrometer designed and built at ETH Zurich (Benz, 2004). This study provides the technical basis to decide whether it is possible to do spectroscopic measurements below 1 GHz ($\lambda > 30cm$) in Birr. This as a precursor for LOFAR. The results are presented and displayed as digitally zoomed spectrums focusing on interesting frequency bands allocated for radio astronomy and other passive services. In terms of electromagnetic interference, Birr castle is ideal for broadband spectroscopic solar radio astronomy observations. It is perfect for broadband observations to detect CME's or to measure quiet solar radio flux at dedicated frequencies. Better locations may rarely be evaluated in the future. Narrow band studies would probably be much better than is already possible in Bleien Switzerland.

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

1. Introduction

In view of IHY, IYA and with the intention for future upgrade of the Birr observatory regarding new radio astronomical instruments, a measurement campaign was planned and organized between TCD, NUI and ETH Zurich. The measurements documented here took place from 29th until 30th of June 2009 at Birr castle, Ireland. This, after installation and configuration of a new Callisto radio spectrometer.

1.1. Station description

The observatory was founded in some-bla-bla.

Coordinate	value
Latitude	$dd^\circ\ mm'\ ss"$ North
Longitude	$dd^\circ\ mm'\ ss"$ East
Height	mmm m above sea level
Local Time	GMT - 01h

Table 1. Geographical coordinates of Birr castle observatory site.

Fig. 1. Callisto receiver and PC at possible LOFAR location at Birr observatory. Callisto powered by lead acid battery. Broad band antenna in the back.

1.2. Measurement instrumentation

We used a commercial DVB-T antenna (see figure 1) directly connected via a low loss coaxial cable to the measuring instrument, see figure 1. The commercial DVB-T antenna covers the range from 20 MHz up to 900 MHz. The Callisto spectrometer e-C19 having a detector sensitivity of 25 mV/dB including control cables and rf adapters was supplied by ETH Zurich. The frequency range of

Abbreviation	description
Callisto	Radiospectrometer of ETH
CME	Coronal mass ejection
CRAF	Committee on Radio Astronomy Freq.
DiRaC	Distributed Radio Spectrometer Control
DVB-T	Digital video broadcast terrestrial
ETH	Eidgenössisch Technische Hochschule
FM	Frequency modulation (Radio)
IDL	Interactive Data Language
IHY	International Heliospheric Year
IYA	International Year of Astronomy
LOFAR	Low Frequency Array
NOAA	National Oceanic and Atmospheric Administration
NUI	National University of Ireland
OFCOM	Office of Communication
TCD	Trinity College Dublin
rf	radio-frequency
TV	Television

Table 2. Acronyms mentioned in labels and comments.

Callisto goes from 45 MHz to 870 MHz in three sub bands. The channel resolution is 62.5 KHz, while the radiometric bandwidth is about 300 KHz. The sampling time is exactly 1.25 msec per frequency-pixel while the integration time is about 1 msec. The frequency in the output data is expressed in MHz and the detector output is expressed in millivolts. Both are stored in a simple ASCII file which can be analyzed with any spread sheet like IDL, Math-CAD or EXCEL. At this location, an additional measurement was taken by switching in a 50 Ω resistor of roughly 300 Kelvin. This, as a reference signal to evaluate the power level in dB above receiver noise level of about 9 dB).

1.3. Acronyms

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

2. Results

2.1. Spectral overview Birr castle Ireland

The total measured spectrum, shown in figure 2 was split into 6 sub spectra in order to allow a detailed inspection. For plots, see figures 3, 4, 5, 6, 7, 8. The total spectrum is composed of 13'200 channels each 62.5 KHz apart. In all plots shown below, 0 dB is referenced to the background noise level given by a 50 Ω resistor.

2.2. Long time observation with CALLISTO

Although the sun was not active at the time of installation and configuration, we observed the sky for several minutes. A single 3 min FIT file, representative of a series of similar observation files, is shown in figure 9 and 10. This was done so as to allow the identification of possible cross modulation by strong transmitters in the FM band and nearby DVB-T transmitters. Only very minor and sporadic cross modulations were detected during the time of observation.

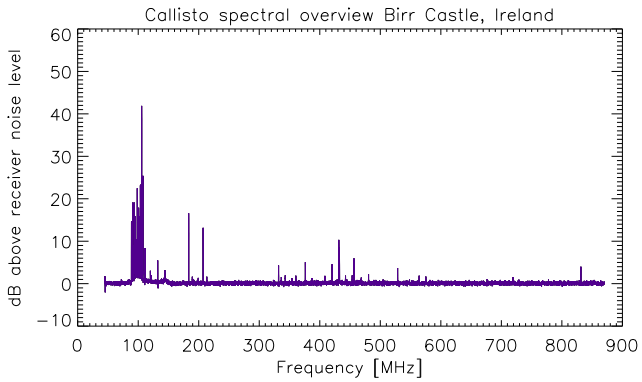

Fig. 2. Spectral overview measured at Birr castle. Only low interference detectable in the FM band and some small carriers by DVB-T signals.

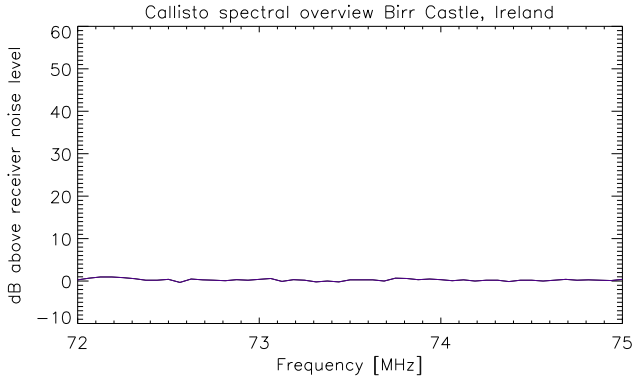

Fig. 3. Spectral overview measured at Birr castle. No interference detectable.

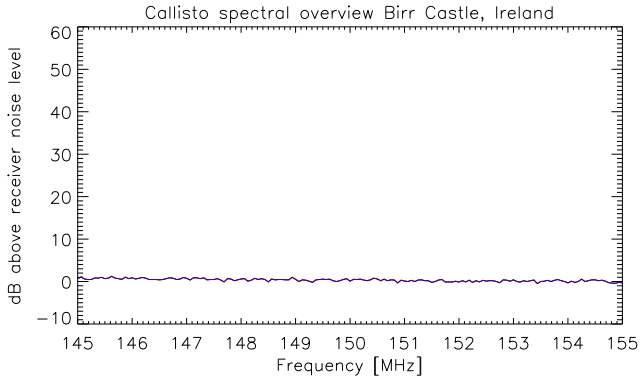

Fig. 4. Spectral overview measured at Birr castle. No interference detectable.

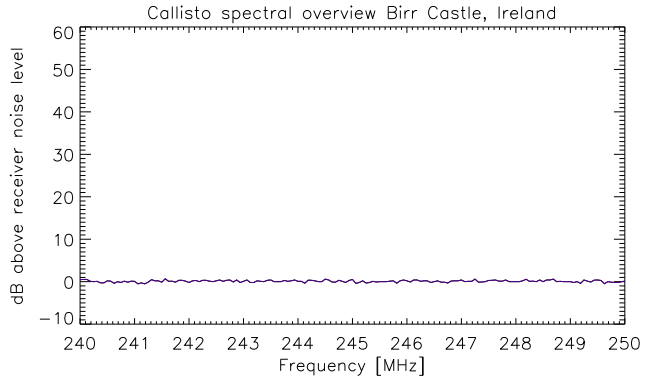

Fig. 5. Spectral overview measured at Birr castle. No interference detectable.

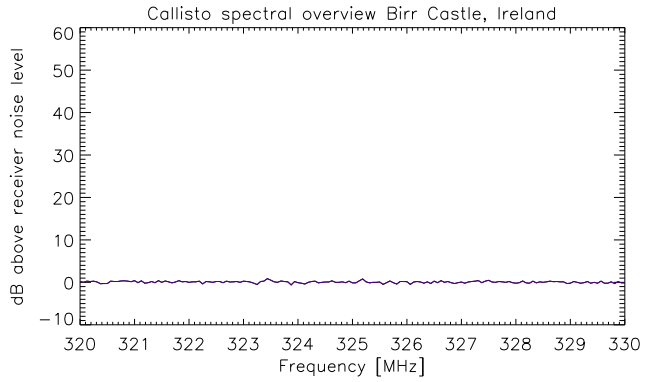

Fig. 6. Spectral overview measured at Birr castle. No interference detectable in the deuterium band.

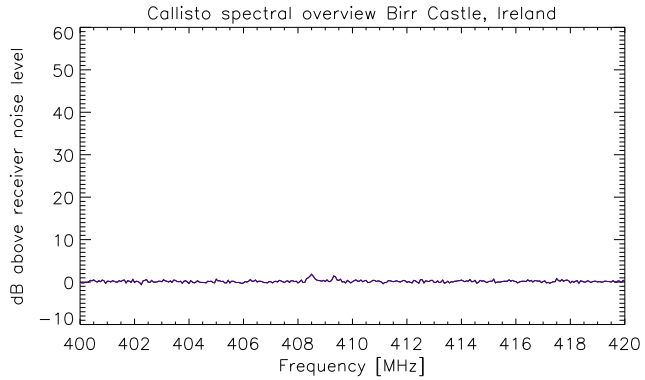

Fig. 7. Spectral overview measured at Birr castle. Only tiny interference detectable in the middle of the band.

3. Conclusions

The radio spectrum at Birr castle is extremely quiet, almost no FM-Radio and almost no DVB-T at the observatory site and hence Birr is perfect as a host site for a solar frequency agile or even an FFT spectrometer. All reserved frequencies are free from interference, and could be used for single frequency observations to determine solar radio flux using broad band antennas. A CME event detection

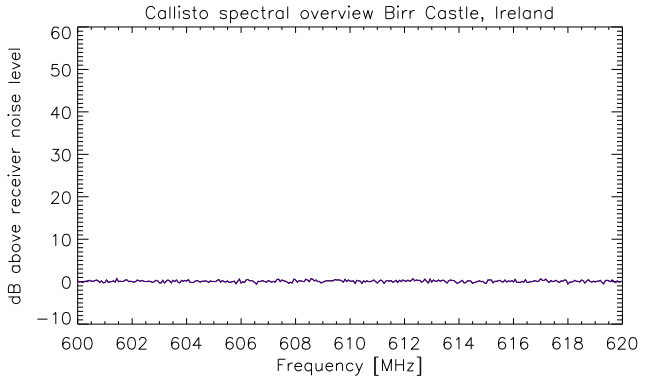

Fig. 8. Spectral overview measured at Birr castle. No interference detectable.

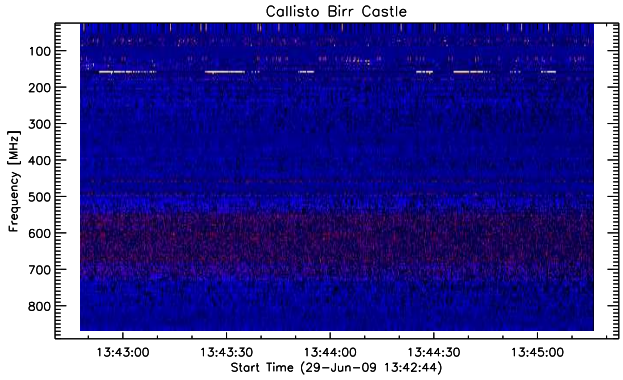

Fig. 9. Couple of minutes high frequency observation at Birr on 29th of June 2009. The x-axis denotes time, expressed in UT and the y-axis denotes frequency in reversed order. Intensity is shown in gamma-II color table. One transmitter around 160 MHz and a carrier around 480 MHz led to interference.

system could be used without any problem. Some more blabla here.

4. Relevant internet addresses

- Birr→ `http://.....`
- TCD→ `http://.....`
- NUI→ `http://.....`
- CRAF→ `http://www.craf.eu`
- CALLISTO→ `http://www.astro.phys.ethz.ch/instrument/callisto/callisto_nf.html`
- IHY→ `http://ihy2007.org/`

Acknowledgements. We especially thank Lady and Lord Ross for spending time and lunch. We also thank Antonin Vydrzel for manufacturing and testing of Callisto eC19.

References

Arnold O. Benz, Christian Monstein and Hansueli Meyer *CALLISTO, A New Concept for Solar Radio Spectrometers*, Kluwer Academic Publishers, The Netherlands, 2004.

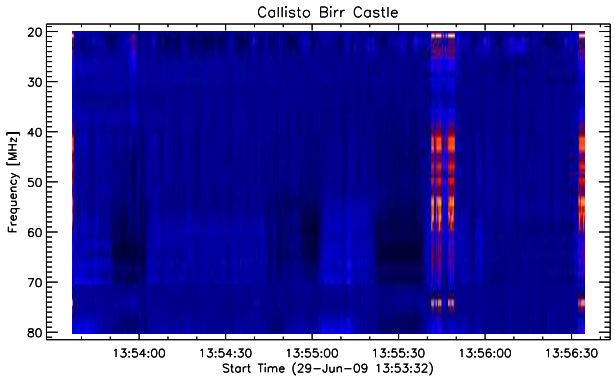

Fig. 10. Couple of minutes low frequency observation at Birr on 29th of June 2009. The x-axis denotes time, expressed in UT and the y-axis denotes frequency in reversed order. Intensity is shown in gamma-II color table. Some interference to the end of the observation was due to switching on the digital camera.

FAX TRANSMISSION FROM:

Birr Castle

+353 57 91 20425

To: Peter T Gallagher, TCD
01 671 1759

Re: Offer of site for Solar Spectrometre

R/jk, 21 September 2009

To whom it may concern

In furtherance of the scientific and technical goals of the proposals submitted to Science Foundation Ireland by Dr. Peter Gallagher of the Astrophysics Research Group, TCD, we are delighted to confirm our happiness to host in the Birr Castle Demesne the Solar Spectrometre which we would be greatly honoured to have named after my most illustrious forbear, the 3rd Earl of Rosse,

Sir Brendan Parsons,
7th Earl of Rosse,
on behalf of the Birr Trustees Co. Ltd and
Birr Scientific and Heritage Foundation.

cc. Richard Wood, Chairman, Birr Trustee Co. Ltd.
cc. Seán Donlon, Chairman, Birr Scientific and Heritage Foundation.
cc. Prof. D. Weaire, TCD, Scientific Consultant, Birr Scientific and Heritage Foundation.