ETH
Eidgenössische Technische Hochschule Zürich
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Northwestern Switzerland

CALLISTO status report/newsletter #56

New Callisto station in Tomohon North Sulawesi, Indonesia:

Timbul Manik from Space Science Center LAPAN, Indonesia recently set up a Callisto system at Tomohon North Sulawesi.

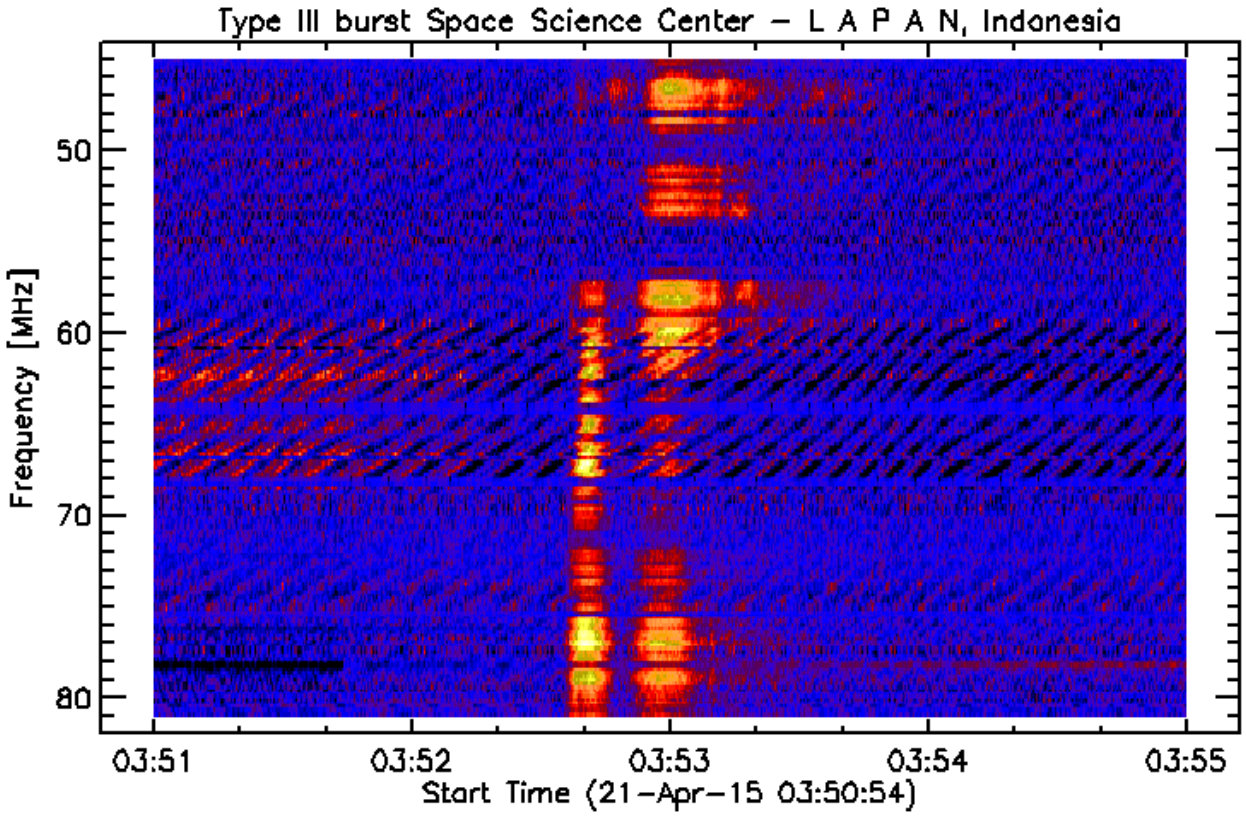

Fig. 1: Low frequency type III solar radio burst from Indonesia. Horizontal structures are due to local rfi

New Callisto in Punta Lobos, Peru

Scientists from CONIDA in Peru found a radio quiet are in Punta Lobos and set up a new Callisto solar radio station.

Fig. 2: LPDA in a very rural area in Punta Lobos, Peru 76,79889 W and 12,51 S. Photo voltaic panels to supply electrical power.

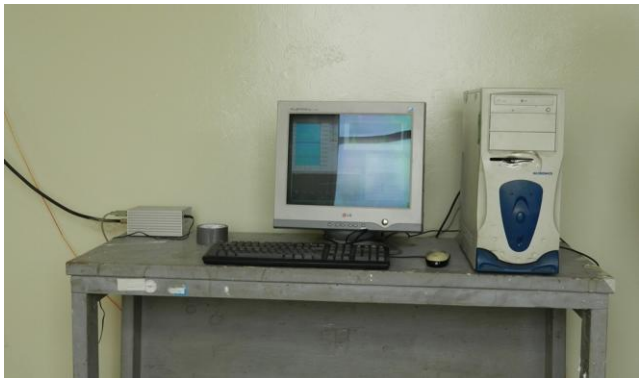

Fig. 3: Callisto and PC in Punta Lobos.

European Solar Eclipse observed by several Callisto

The Sun radiates not only at visual wavelength but also in ultra-violet, X-rays and, among others, also at radio wavelengths. The institute for Astronomy at ETH Zurich has operated two small radio telescopes for more than 30 years at Bleien Observatory, about 50 km south of Zurich. These use 5 and 7 m parabolic dish antennas connected to CALLISTO frequency agile radio spectrometers, which are used as cheap and reliable back-ends. In the future they will be replaced by high speed, high dynamic FFT-spectrometers to improve sensitivity and resolution in the time and frequency domains.

Both dish antennas were originally designed and built explicitly for solar radio observations. Despite the considerable research at ETH and elsewhere, one of the burning questions is what causes the Sun's coronal heating. There are many theories about it but none of them can cleanly and clearly explain how the high coronal temperature of millions of kelvins is produced. A solar eclipse, such as the one of 20 March 2015, is ideal to study the geometrical structure and temperature at different heights above the Sun surface.

The telescopes at Bleien Observatory track the sun automatically every day from sunrise to sunset independent of weather conditions. Radio telescopes such as these can observe the Sun through clouds and rain with only minor attenuation of the received emissions. In figure 4 we see three light curves of the 20 March eclipse produced by the 7 m dish antenna. The dish antenna is shown in figure 5.

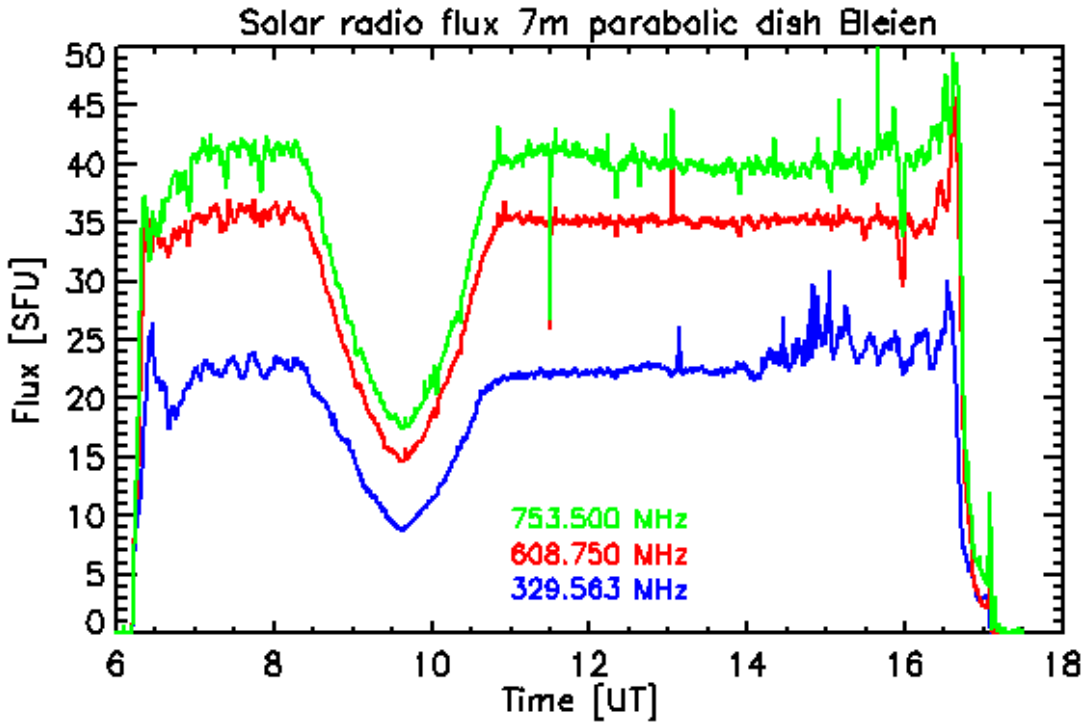

Fig 4: ~Light curves of three frequencies in UHF range observed with the 7 m dish antenna, which tell us something about the dimensions and temperatures at higher layers in the solar corona.

The traces show sunrise around 06:15 UT and around 08:30 UT we observe a decrease in the radio flux due to shadowing of the Moon disc during the eclipse on 20 March. Maximum occultation of the Sun by the Moon corresponds to the minimum in the light curve at around 09:30 UT. Close to 11 UT the partial eclipse is finished and the radio flux remains constant until about 16:30 UT except for some negative drift due to temperature changes. Sunset is around 17 UT and we can see that even the bushes and trees at the horizon radiate at radio frequencies with a level of 1 ... 3 sfu (solar flux unit).

Fig. 5 ~ Parabolic dish 7 m diameter for observing from 100 MHz up to 4000 MHz in dual circular polarization at Bleien Observatory. On April 22th, 2015 solar observations have been switched off.

The radio telescopes continue tracking the Sun even below the optical horizon due to refraction. Therefore, at radio wavelengths we can observe the Sun a few minutes longer than at optical wavelengths. Shortly after 17 UT every night the antennas are automatically parked at a fixed 180° azimuth and 30° elevation as preparation for the following day. The radio flux at the parked position is less than 1 sfu (Note: 1 sfu = 10 000 Jansky = 10^{-22} W/m^2/Hz). The strongest radio source in the sky radiates in the order of 2000 Jansky, corresponding to 0.2 sfu.

In figure 6 we observe the light curves of the eclipse received at microwave frequencies between 1000 MHz and 1256 MHz with the 5 m dish. These frequencies correspond to wavelengths of 30 cm to 23.8

cm. This frequency range will be used in the future for cosmological observation of the low red-shifted hydrogen line. In the case of the Sun, these wavelengths are radiated from lower layers in the corona where the temperatures are just a few thousand kelvin. The light curves for some frequencies show oscillations during sunrise and sunset. This is interference between the direct radiation received from the Sun and reflected radiation received from the ground.

And in figure 7 the same eclipse was also observed at Humain which is the radio telescope location of the Royal Observatory of Belgium (ROB). It's again a Callisto hooked up to a 6m parabolic dish, tracking the sun.

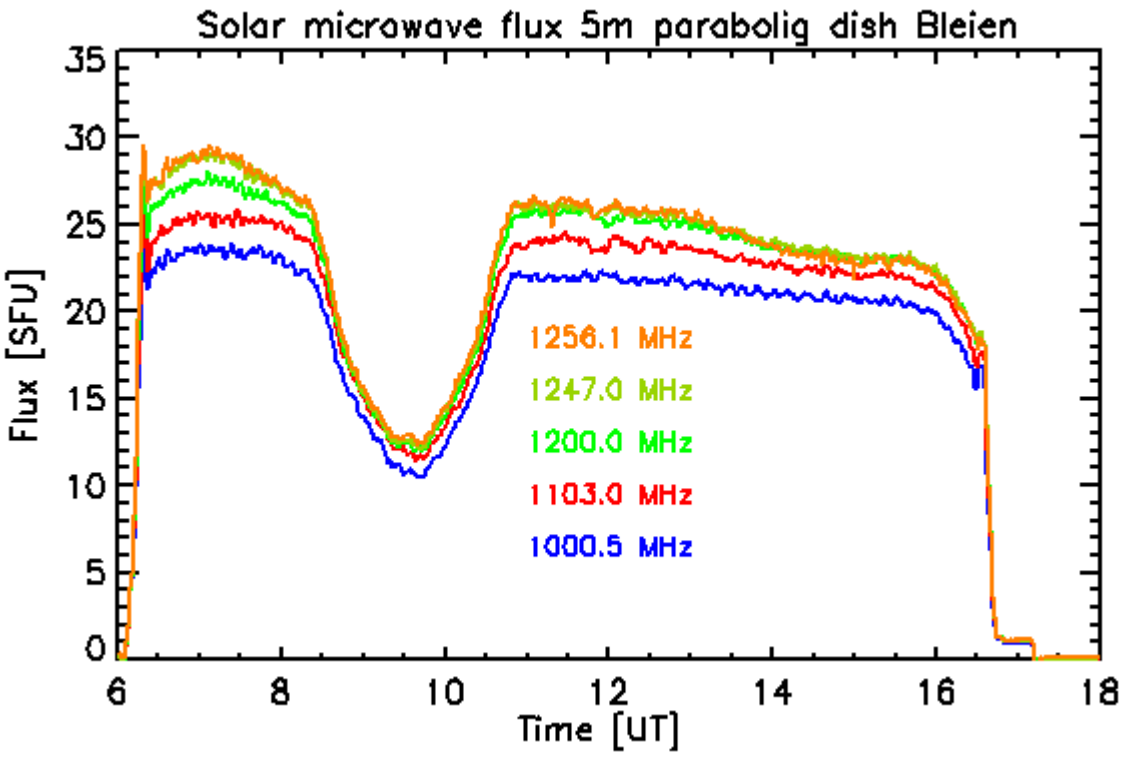

Fig. 6: ~Light curves of 5 microwave frequencies received by the 5 m dish have a similar shape to those seen with the 7 m dish.

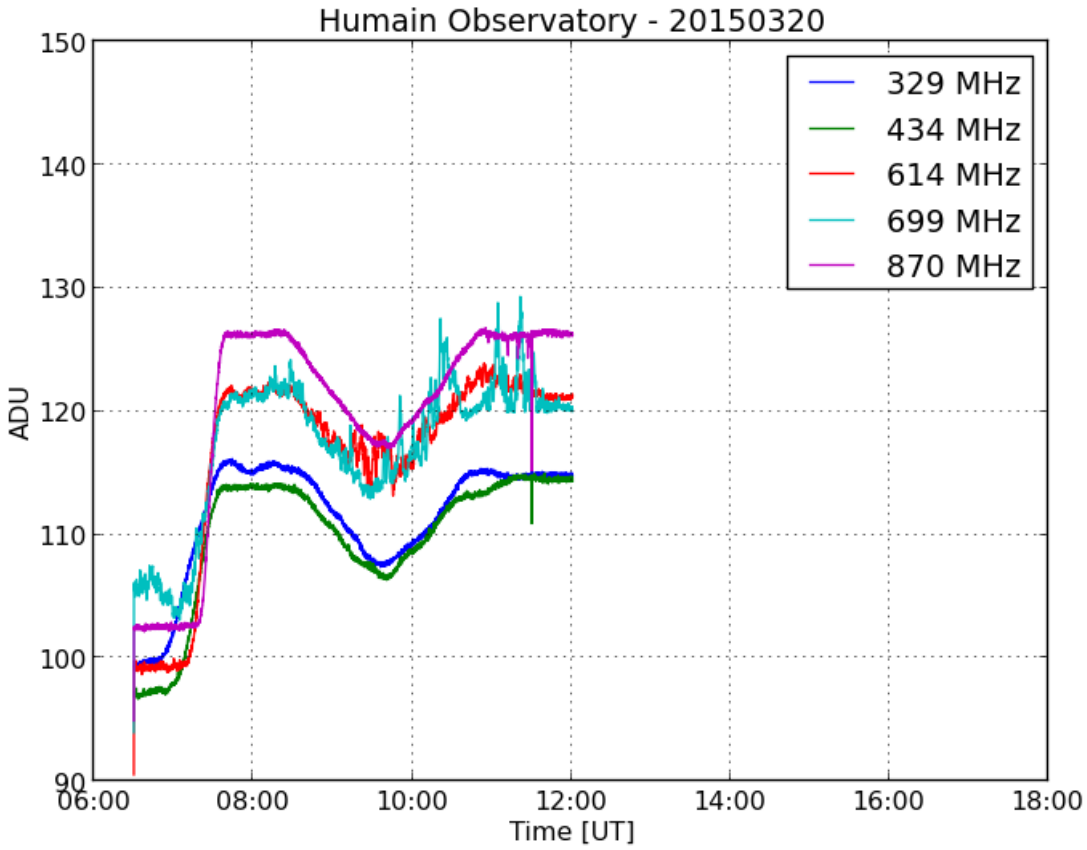

Fig. 7: ~Light curves of 5 different meter-wave frequencies, received by a 6 m dish at Humain, Belgium.

Strong RFI Observed in the Protected Deuterium Band at Bleien Observatory (RSG), Switzerland

Abbreviations
DAB-T: Digital Audio Broadcasting – Terrestrial
LED: Light Emitting Diode
RFI: Radio Frequency Interference
UT: Universal Time

Beginning in December 2014 strong sporadic radio frequency interference (RFI) was observed at Bleien Observatory in the frequency range 200 to 450 MHz. The intensity was stronger than the quiet Sun. It usually started around 0600 UT and lasted 10 to 20 minutes. On weekends, Saturday and Sunday, the RFI was on for at least one hour and sometimes up to 4 hours. Coincidentally, the nearby farmer lamented that he could not listen to DAB-T anymore and therefore procured a new radio receiver. Unfortunately, listening was still not possible with the new receiver in the morning and weekends.

I sent a short report to the Federal Office of Communications of Switzerland, OFCOM, about the facts found so far, and we discussed several procedures on how to identify the RFI source. The farmer and I started to note times of RFI and we compared the results. We noted that when I could not observe the

radio Sun below 1 GHz due to the RFI, the farmer's family could not listen to the radio. However, we were unable to identify the RFI source.

On March 11, I went up to the observatory at 0500 UT to make live observations of the RFI and to find its direction. I planned to use the 7 m dish antenna over a 50 to 270° azimuth range and 5° elevation in both left-hand and right-hand circular polarizations. Unfortunately, I was 45 minutes late and the RFI shown in figure 8 had already ceased. I went up even earlier on March 12 at 0400 UT. I positioned the 7m dish at 108° azimuth and 4° elevation, directly at the farmer's house, and just waited while watching the spectrometer display.

At precisely 0620:20 UT the RFI suddenly appeared very clear and strong as seen in figure 9. I immediately called the farmer by phone and asked for permission to conduct radio measurements in his home, see figure 10. He said yes, so I started direction finding using the handheld spectrum analyzer and directional antenna shown in figure 11. I found nothing serious on the ground floor but detected strong RFI on the 1st (upper) floor, the flat of the farmer's son Samuel and his girlfriend. The living room showed strong RFI in all directions.

To isolate the noise source we switched off all electrical gadgets one at a time including smart-phone chargers, coffee machine and the lights. As soon as the light was switched off, the RFI disappeared, see figure 9. We pulled all illumination devices one at a time and found that an LED lamp in figure 13 was the source of RFI. The light had been ordered at the beginning of December 2014 from the web-shop **LED.CH**. The only information available on the LED and on the box is: MR16 3*1W 12V WARM WHITE CE. Now, with the LED off we can observe the Sun again and the farmer's family can listen to DAB-T.

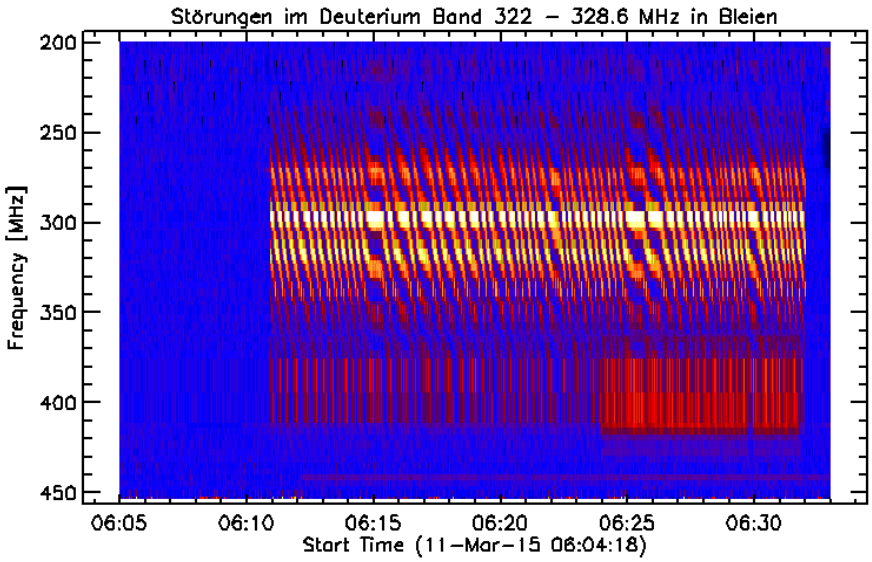

Fig. 8 ~ RFI on Wednesday, 11 March 2015 early morning 07:10 local time, the usual time when people get breakfast bevore going to work. On this day, I was too late to track and identify the source of RFI.

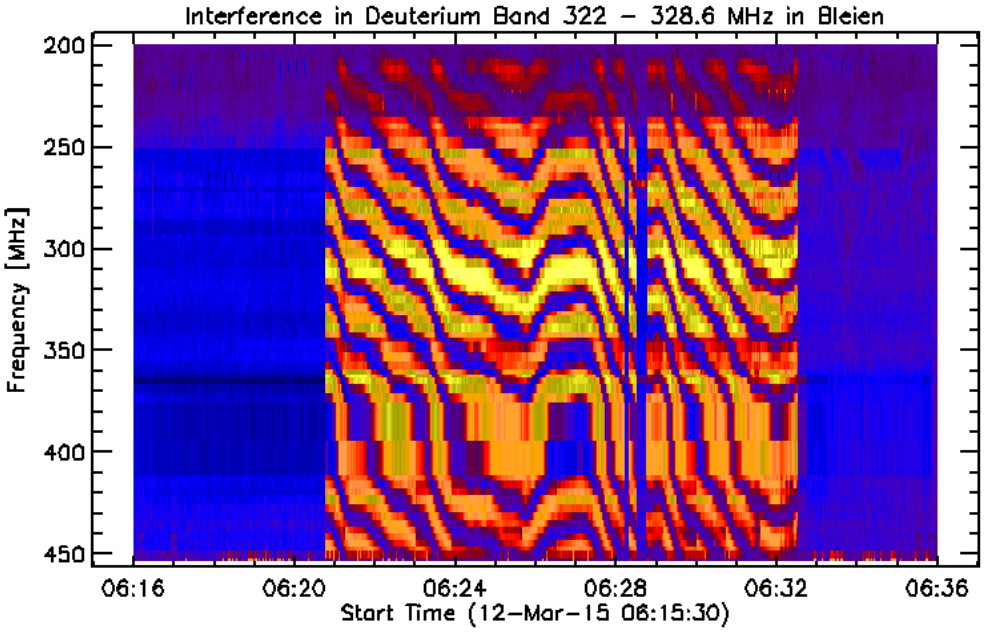

Fig. 9 ~ RFI spectrum on Thursday, 12 March.2015. LED was switched on at 06:21 UT to enjoy breakfast and light was switched off around 06:28 UT for checking. At 06:32 UT the LED was removed from the installation.

Fig. 10 ~ 7 m dish left pointing to the Moon with the farmers' house in the background right. Samuel's living room is on the 1st (upper) floor right-most window.

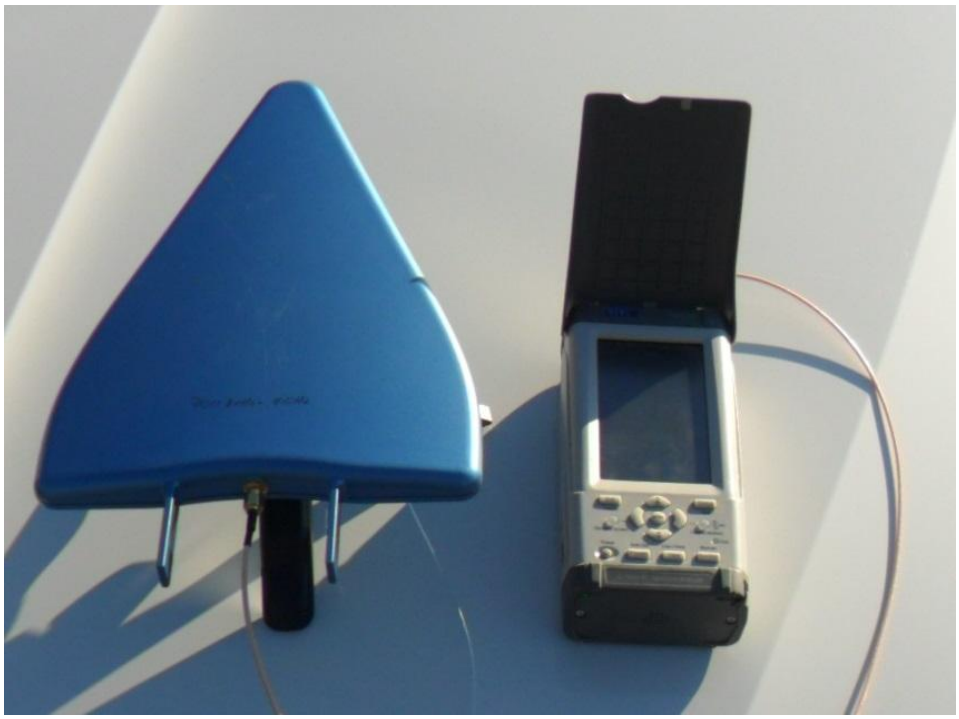

Fig. 11~ Logarithmic periodic dipole array (LPDA) from AARONIA, type HL 7040 covering 700 MHz – 4 GHz (left) and 2.7 GHz RF Spectrum Analyzer PSA2702 from TT*i* (right) connected via a thin SMA coax cable to the LPDA. Frequency range was adjusted to cover 200 to 400 MHz. For spectrum, see figure 12.

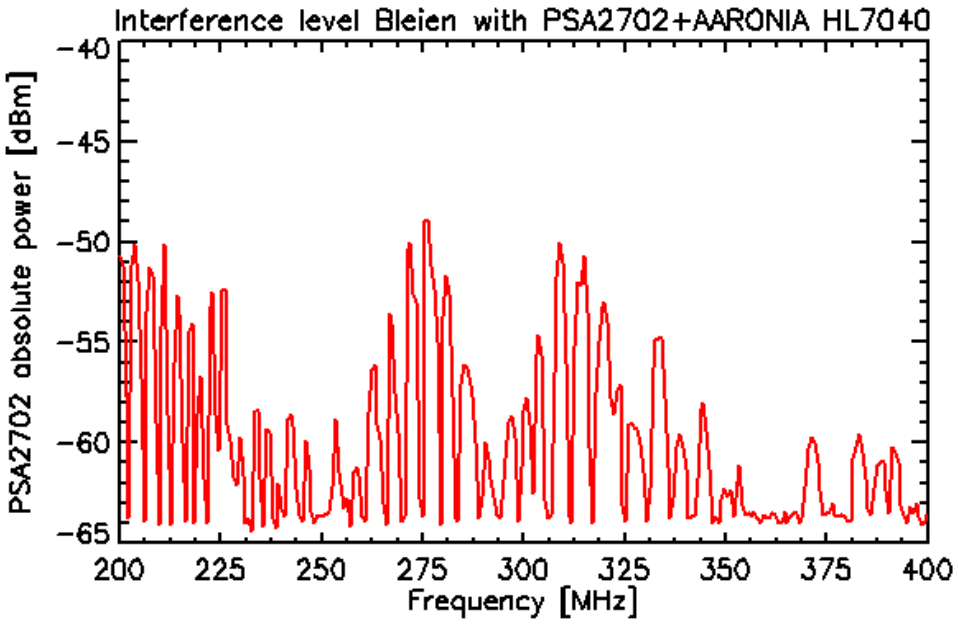

Fig. 12~ Observed spectrum close to the RFI-producing LED in 1st floor of Samuel Brunners home. The antenna low frequency design limit is 700 MHz (!); nevertheless quite some power was received, much stronger than the quiet Sun‘s radio radiation.

Fig. 13 ~ Guilty LED of type MR16 3*1W 12V WARM WHITE (CE), procured from LED.CH for CHF 28.60 per unit. The LED was parallel to a few other incandescent lamps and was driven by a 12V ac-transformer.

- CALLISTO or Callisto denotes to the spectrometer itself while e-Callisto denotes to the worldwide network.
- General information and data access here: http://e-callisto.org/
- Callisto software does operate also under Win 8.1
- e-Callisto data are hosted at Fachhochschule Nordwestschweiz (University of applied sciences FHNW) in Brugg/Windisch, Switzerland. Process control, user communication and scripts are conducted at institute for Astronomy, ETH Zurich.

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