FM notch filter in front - and - behind the low noise amplifier of a Callisto Radio Spectrometer in Gauribidanur, India

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Abstract

In the framework of IHY2007 a Callisto spectrometer was installed and set into operation at the location of the solar heliograph in Gauribidanur, India. At that time the level of rfi was amazingly low. In recent years more and more FM-transmitter were installed with high power compared to the requirements of radio astronomical observations. So, the spectral observations with Callisto got more and more interfered by these FM-transmitters. Recently a FM-notch filter was installed between low noise amplifier and Callisto which didn't work out really. Then the notch filter was moved to the input of the LNA and the result was much better, as expected from theoretical concepts.

Keywords: Callisto, rfi, notch filter

Interference due to nearby FM-transmitters

The nearby FM-transmitters produce a lot of interference into the chain of low noise amplifier and Callisto spectrometer. A notch filter between LNA and Callisto suppresses signal but it's already too late because the LNA got saturated by the FM-signals introducing vertical structures in the spectrum.

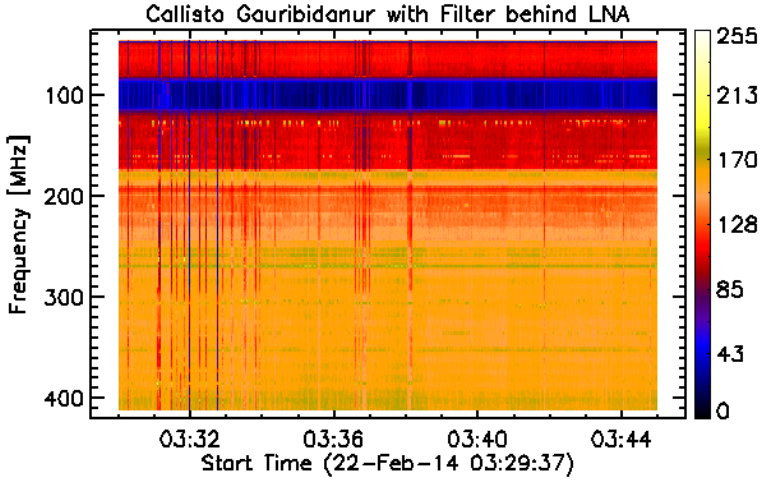

Figure 1~ FITS-file observed with notch filter between LNA and Callisto. Signal between 80 MHz and 115 MHz is attenuated but, the LNA is suffering from strong FM-transmitters which produce cross-modulation inside the LNA due to saturation in the semiconductors (non-linear range). This plot shows raw data with no manipulation. Saturation and cross-modulation introduced by strong FM signals produces vertical stripes in the spectrum over all frequencies.

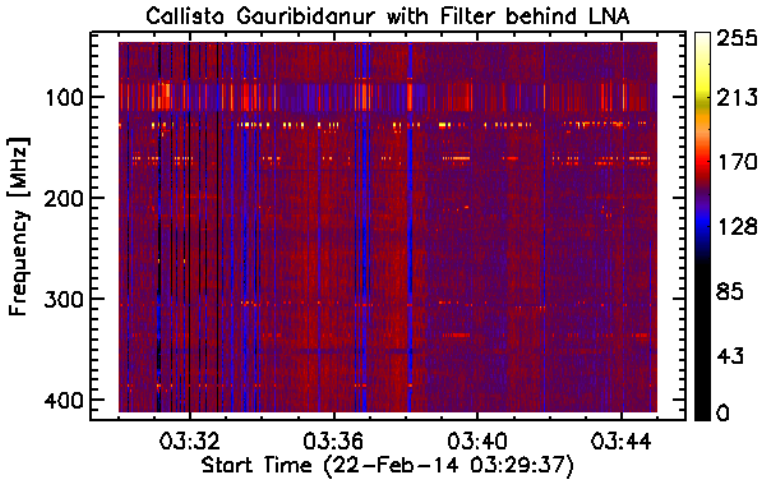

Figure 2~ This plot shows the same data as in figure 1 but here with background subtracted. Now we can better see the vertical structures much better introduced by interference from nearby FM-transmitters. Data quality is quite bad and makes it difficult to find and analyze solar radio bursts.

The signal chain should be protected from strong man made signals which can be easily conducted by inserting a FM-notch filter which suppresses all signals between ~80 MHz and ~115 MHz. So the only way to improve the situation is to switch in the notch filter in front of the signal chain at the input of the

LNA. This action was carried out on March 15th 2014. Since then the situation improved drastically, cross-modulations can hardly be found in the dynamic spectra, see figures 3 and 4.

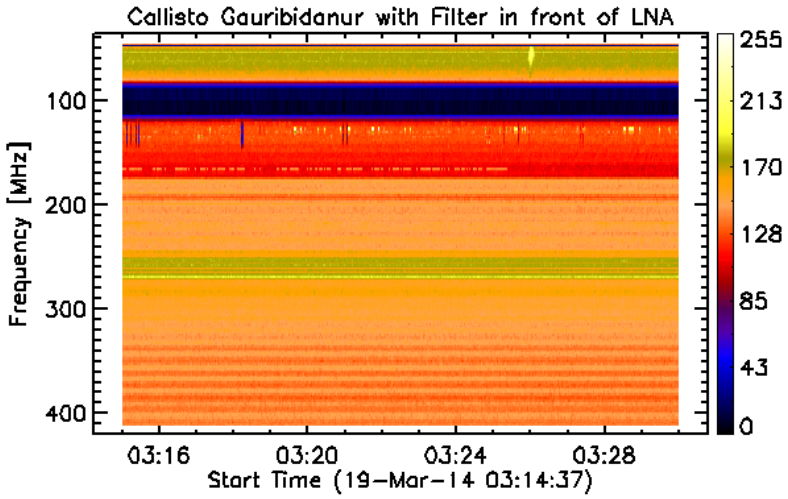

Figure 3~ Spectrum with a notch filter which was inserted in front of the LNA. The notched band can clearly be identified around the FM-range (black horizontal area). Only minor cross-modulation takes place, probably introduced due to air-communication around 128 MHz. Near 03:26:01 UT and below 85 MHz we can identify a small type III solar radio burst. In this plot background is not subtracted, it shows original data as observed by Callisto spectrometer.

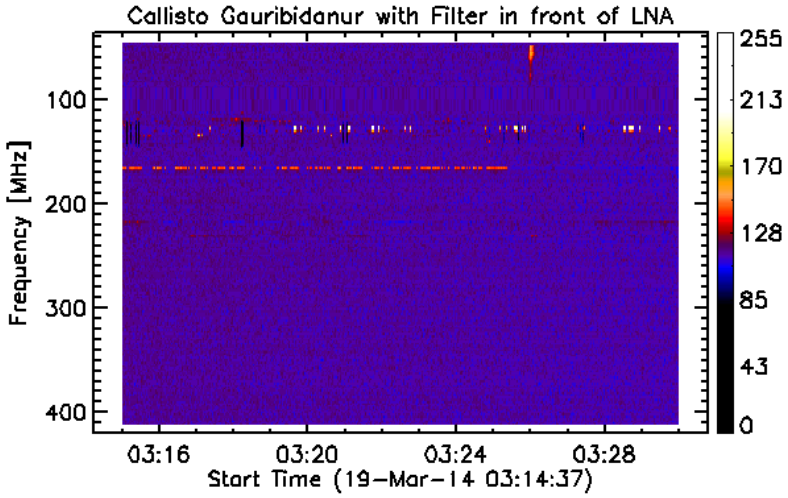

Figure 4~ The same spectrum as shown above in figure 3 but, now with background subtracted. There is only minor interference detectable around 165 MHz, most probably radio-communication by security or fire brigade. The solar type III burst can clearly be identified and scientifically analyzed.

Conclusion

It has been demonstrated, that a notch-filter can help to get rid of interference but only by accepting data loss in the notched band, of course. It's very important to switch in the filter as close to the interferer as possible, in our case between antenna and low noise amplifier. There is no sense to put the amplifier between LNA and spectrometer because the LNA is already saturated and so producing interference into the spectrometer. Now the general data quality is much better than before and we hope that in the future no new strong transmitter will be set into operation. In principle we can switch several notch-filters in series to get rid of more than one transmission. But the insertion loss is also increasing which reduces the instrument sensitivity. Therefore, it's better to avoid any nearby transmission or to put the instruments at a remote area without any interfering transmitters.

Links:

Callisto general information: http://www.e-callisto.org/
Access to the data archive: http://soleil.i4ds.ch/solarradio/callistoQuicklooks/

References and further reading

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

Meet the author: Christian Monstein is a native of Switzerland and lives in Freienbach. He obtained Electronics Engineer, B.S. degree at Konstanz University, Germany. Christian is a SARA member since 1987 and is licensed as amateur radio operator, HB9SCT. He has experience designing test systems in the telecommunications industry and is proficient in several programming languages including C and C++. He presently works at ETH-Zürich on the design of digital radio spectrometers (frequency agile and FFT) and is responsible for the hardware and software associated with the e-CALLISTO Project. He also has participated in the European Space Agency space telescope Herschel (HIFI), European Southern Observatory project MUSE for VLT in Chile, and NANTEN2 (delivery of the radio spectrometer for the Submillimeter Observatory at Pampa la Bola, Chile). Currently he is quite involved to prepare the radio telescopes for cosmological test observations. He plays also the role of a coordinator of SetiLeague in Switzerland. Email: monstein@astro.phys.ethz.ch