Installation of the new electronics for the Helix array (Malargue December 2016)

Abstract

We present here a first report on the installation of the helix antennas with the new electronics. We show also onsite measurements.

1 Introduction

The setup in the L-band (1-1.5GHz) was installed in march 2015. It is composed of an helix antenna, an amplifier stage, and an adaptation stage. The data collected in 2015 showed no sensitivity and strange behavior. In May 2016 all the detectors from the helix hexagon were removed and tested [1]. Several issues were spotted:

- mechanical: the ring of the reflector was broken
- at the amplifier stage: almost all the amplifiers failed, probably due to electrostatic discharge (ESD).
- the adaptation board had setting issues on the dynamic range

These issues were addressed by: reinforcing the reflector's ring and putting ropes to tie the reflector to the central part; designing an amplifier board with a ESD protection at its entry stage(description and calibration can be found in [2]); changing a few components on the adaptation board.
We present here the installation of the new setup with these new features.

2 Installation sum up

The antennas were already prepared, we had repaired them in May 2016. The electronics boxes were brought from Paris for this trip. We prepared 16 amplifier boxes (8 with an input filter, 8 without) and 7 adaptation board boxes.

2.1 preliminary tests

Before performing the installation, we have two questions to answer:

- is the input filter necessary ?
- is the electric line located on the road (see Figure2) a source of noise ?

The first day we went for a survey of the helix hexagon to be sure all the tanks were easy to access. We also made measurements to answer the questions listed above. Figure 1 (left) shows a spectrum recorded on the road close to the tank Santy, one is taken without filter (blue) and the other with (green). The spectrum without filter shows a ringing behavior with peaks at regular intervals. These intervals are $\simeq$ 100MHz long, so the ringing could be caused by the FM band. Even if the spectrum in our band of interest seem unchanged with or without filter, we cannot operate with a saturated amplifier. We choose the filtered version, even if we know the noise temperature is higher.
As for the electric line, we recorded spectra with the antenna pointed either toward the line (in blue in Figure 1 (right)) or facing the opposite direction (in green). No significant change is observed, so the line does not produce noise on our setup.

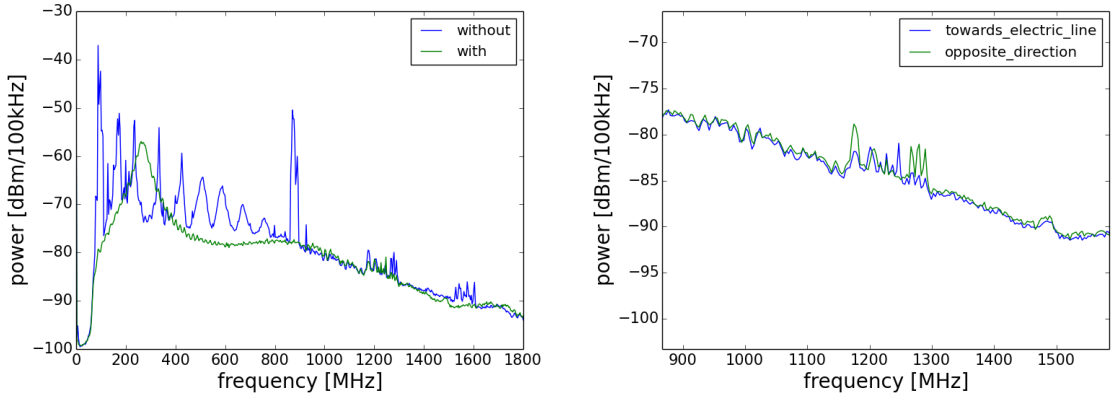

Figure 1 spectra with and without filter close to the tank Santy

2.2 Installations

After the preliminary tests we drove to all the tanks we will install an helix detector, i.e. the hexagon centered on Santy (cf Figure 2). We took the opportunity that day (2016/12/07) to install two antennas: Santy and Jorge. The next day (2016/12/08) we installed the other antennas in the morning. The order we proceed is the following: Rula, Nono, Gringa, Gilda, Eva.

The procedure for the installation is:

- install the antenna on the support (which was left from the first installation)
- install the electronics box
- record a spectrum
- record waveforms with the Picoscope
- connect the signal to the UB

remark: the adjustable resistor setting was not modified

The table 1 reports on the device number installed (antenna, LNA, adaptation box). A more detailed description of the measurements taken on site can be found in [3]. We had

Table 1 installation record

tank	date	antenna	LNA	adaptation box
Santy (339)	07 Dec.	FPV7	AF8	box 12
Jorge (329)	07 Dec.	FPV8	AF7	box 5
Rula (313)	08 Dec. (9:20 - 9:40)	FPV4	AF4	box 11
Nono (340)	08 Dec. (10:05 - 10:30)	FPV6	AF6	box 9
Gringa (328)	08 Dec. (10:35 - 11:00)	FPV2	AF2	box 2
Gilda (334)	08 Dec. (11:11 - 11:30)	FPV3	AF3	box 3
Eva (330)	08 Dec. (11:40 - 12:20)	FPV5	AF5	box 10

no particular issue during the installations and we spent approximately 30 minutes per tank. The pictures of the antennas once installed can be found on the Figure 3.

Remark: We went on Gringa and Nono a second time on the 11th and 12th, see section 4 for more details

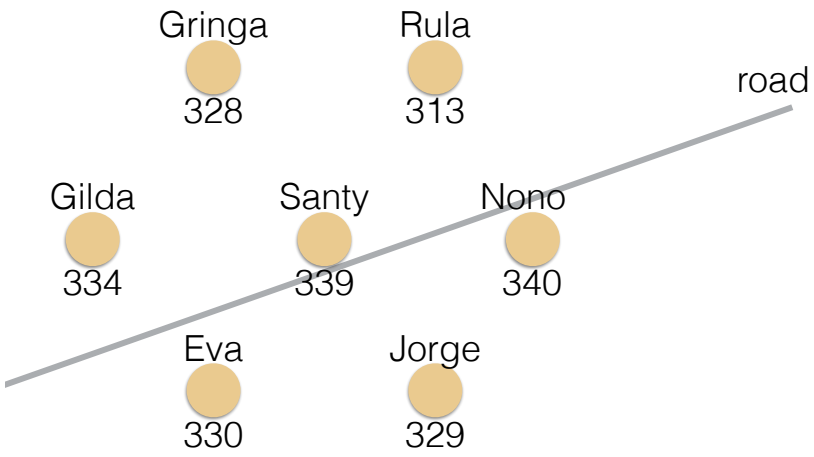

Figure 2 hexagon where the helix array is installed

Figure 3 Picture of all the antennas (except Jorge)

3 First observations

We recorded data during the installation to check that the detector was operating correctly but also to measure the ambient noise.

3.1 spectra

On all the tanks we recorded a spectrum, in RMS mode, to measure the noise floor . They are all presented on the Figure 4. We see already on this spectra that there are peaks inside

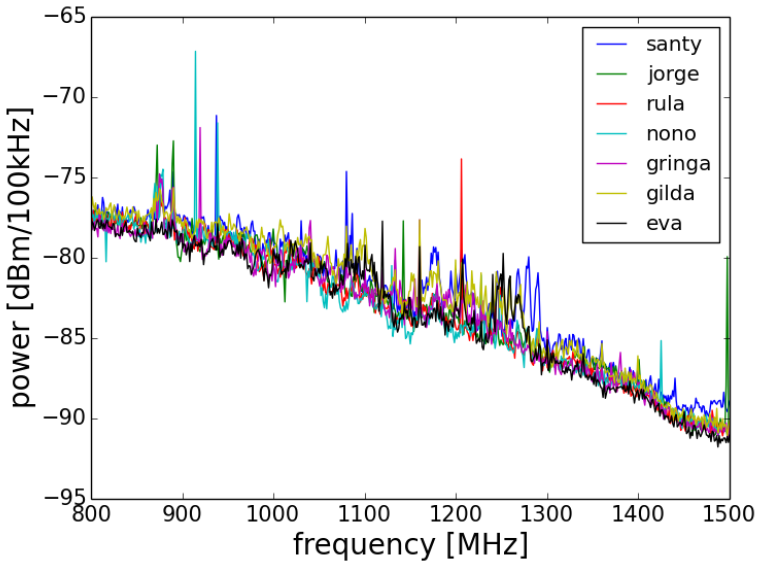

Figure 4 spectra in RMS mode on all the 7 detectors installed

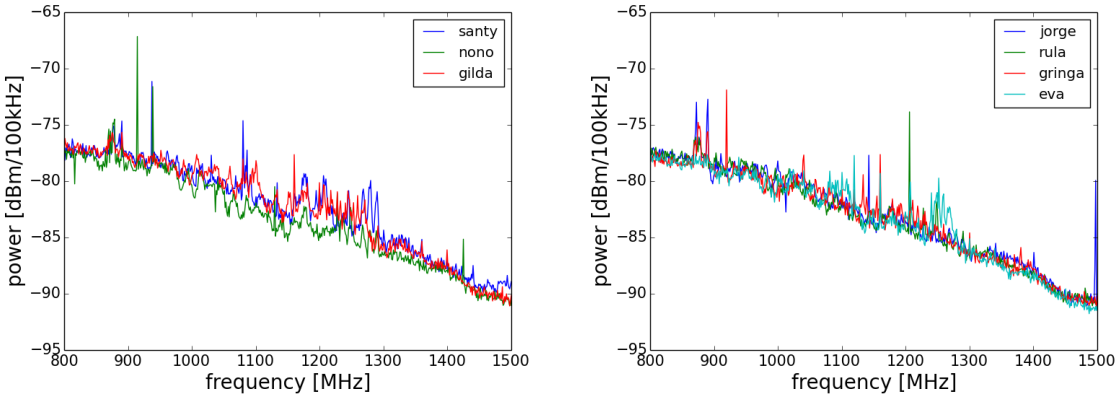

Figure 5 spectra of detectors close to the line (left) and further away (right)

our band. With the same data we can also check that the noise is not significantly larger in

the detectors close to the electric line (cf Figure 5).
We also recorded spectra in peak mode but only for the five detectors installed on the second day. We show in Figure 6 for each detector approximately 15 to 30 spectra recorded consecutively. The spectra recorded on Rula and Nono were taken with 20dB of attenuation because the peak from the Auger radio (940MHz) was to large and was causing the saturation of the spectrum analyser. As a result, on those two detectors we see less peaks but this is probably due to the spectrum analyzer attenuation. It seems that there are peaks in our band, they are

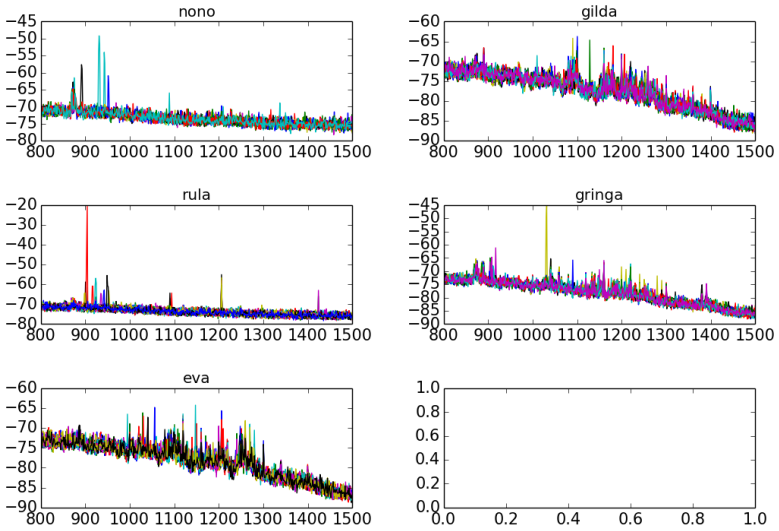

Figure 6 spectra taken in peak mode

not obvious when spectra are taken in RMS mode (Figure 4) but appear consistently when spectra are acquired in peak mode.

3.2 waveform

We also recorded waveform with the Picoscope. An example of a 20μs long waveform recorded on Rula is shown in the Figure 7.

In the real data, the waveform is slightly different because there is a 20MHz filter at the input of the front end. This measurement allows us to measure the baseline and have an idea of the transient noise. The distribution of the amplitudes of 50 traces of 20μs is shown in Figure 8. The average baseline and RMS are reported in table 2.

Table 2 average value of amplitude (mean of the distributions of the fig 8), standard deviation on the average of the 50 traces recorded and standard deviation of the distribution

tank	santy	jorge	rula	nono	gringa	gilda	eva
mean [V]	-1.285	-1.210	-1.245	-1.396	-1.293	-1.341	-1.243
std(mean) [V]	0.001	0.007	0.011	0.23	0.003	0.002	0.007
rms [V]	0.236	0.238	0.239	0.358	0.256	0.254	0.250

For all the antennas, the baseline is around -1.3V but their amplitude distributions have

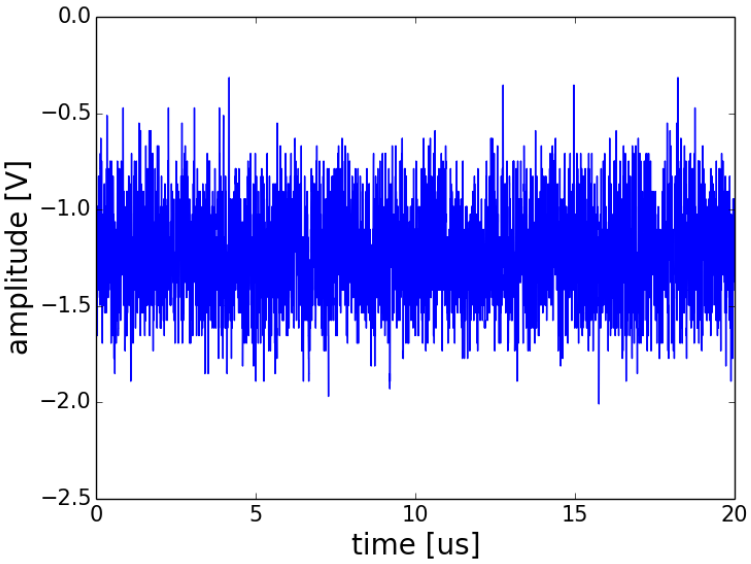

Figure 7 example of a trace recorded on Santy tank

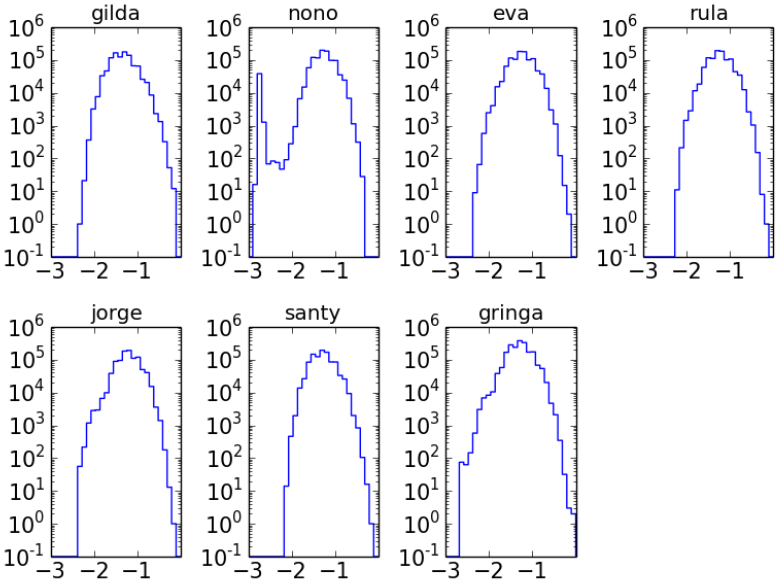

Figure 8 distribution of amplitudes, voltage in x axis and entries in y axis

a different shape. Especially Nono has a large contribution at around -3V, Gringa or Jorge have also a tail at large negative value. The tail in the distribution can be explained by the presence of transient noise. This is confirmed by the triggered traces we recorded on Jorge. Some examples of these waveforms are shown in Figure 9.

By looking at longer waveform (of the order of the second), see for instance Figure 10, we

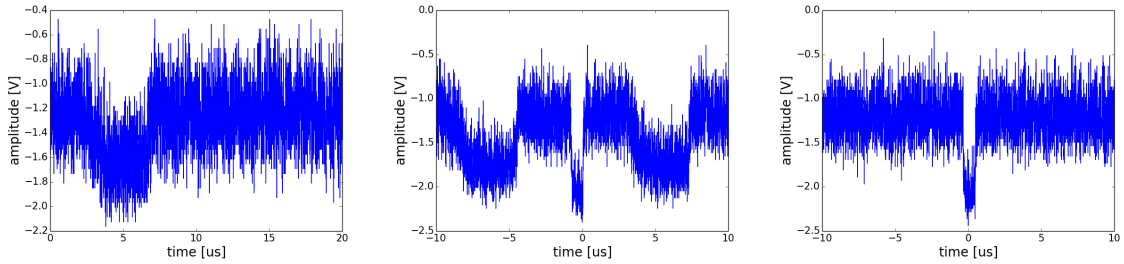

Figure 9

see a strong transient noise every second in the case of Nono. It appears also in Gringa, and probably in Rula (but I lost the file...). This peak appears every second and is 10ms long. This noise is very likely coming from the Auger comms. The waveform and spectra of Gilda and Eva are much cleaner.

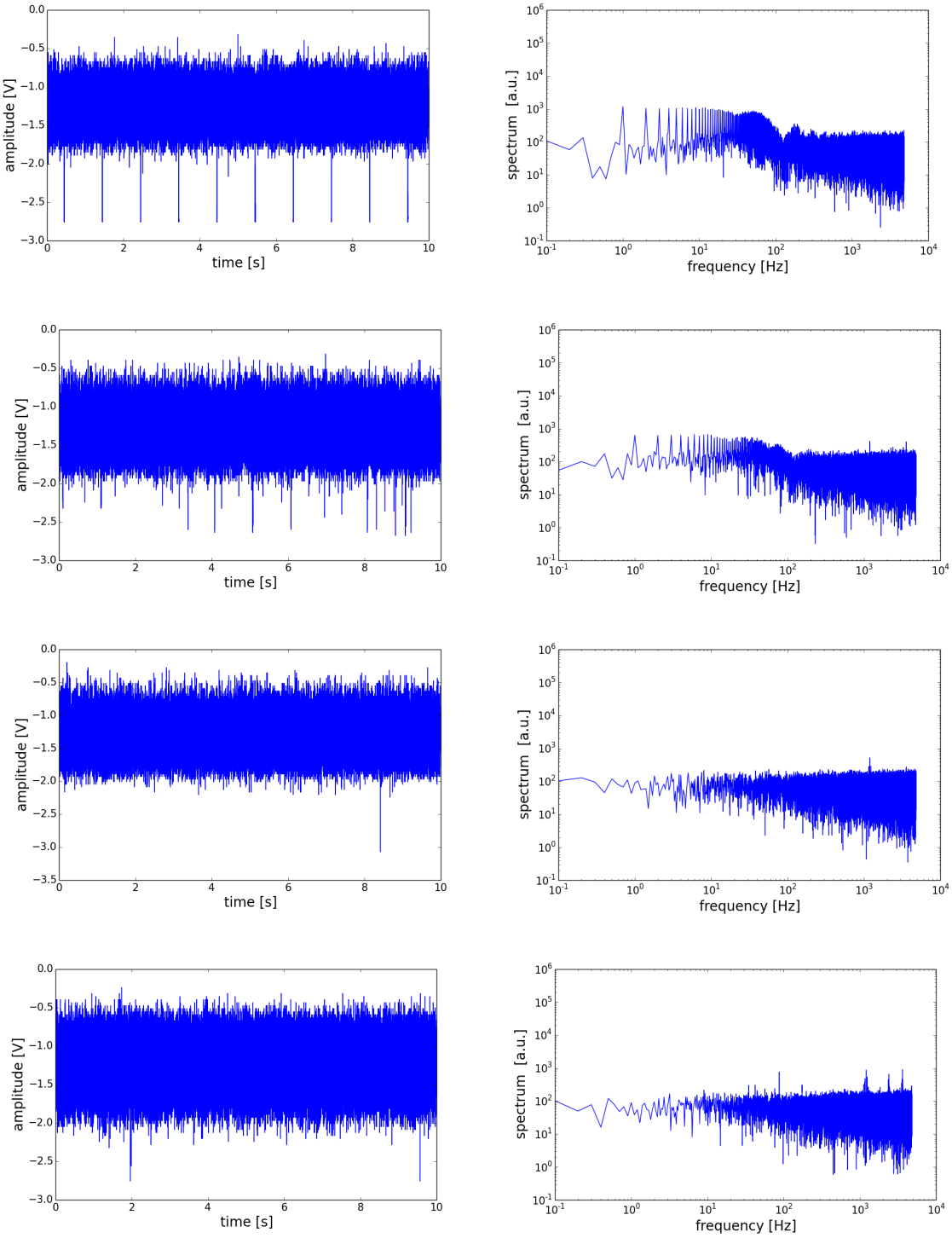

Figure 10 from top to bottom: Nono, Gringa, Gilda, Eva

3.3 monitoring

The baseline can be checked with the monitoring data, see Figure 4. Firstly, we see that the baseline value matches the baseline voltage measured with the picoscope on site (650ADC count correspond to around -1.3V). Unfortunately we see that Gringa seem to be broken. This might be due to a strong wind that occured during the night 9th to the 10th and during the whole day of the 10th.

We can also note that the baseline varies less than in the C-band, there seem to be less temperature dependence.

The helix antennas are tilted toward the center of the hexagon, only the central detector points toward the zenith. So we expect different signal from the sun depending on the antenna. In this season, we expect to see a bump from the sun in five antennas (all of them except the two pointing toward the south: Rula and Gringa). The sun is very clearly visible in Eva and Gilda. It is also visible, but less clearly, in Jorge and Santy, however it is really not obvious in Nono. This means that Nono is less sensitive than the other antenna. It can be due to the larger transient noise it receives.

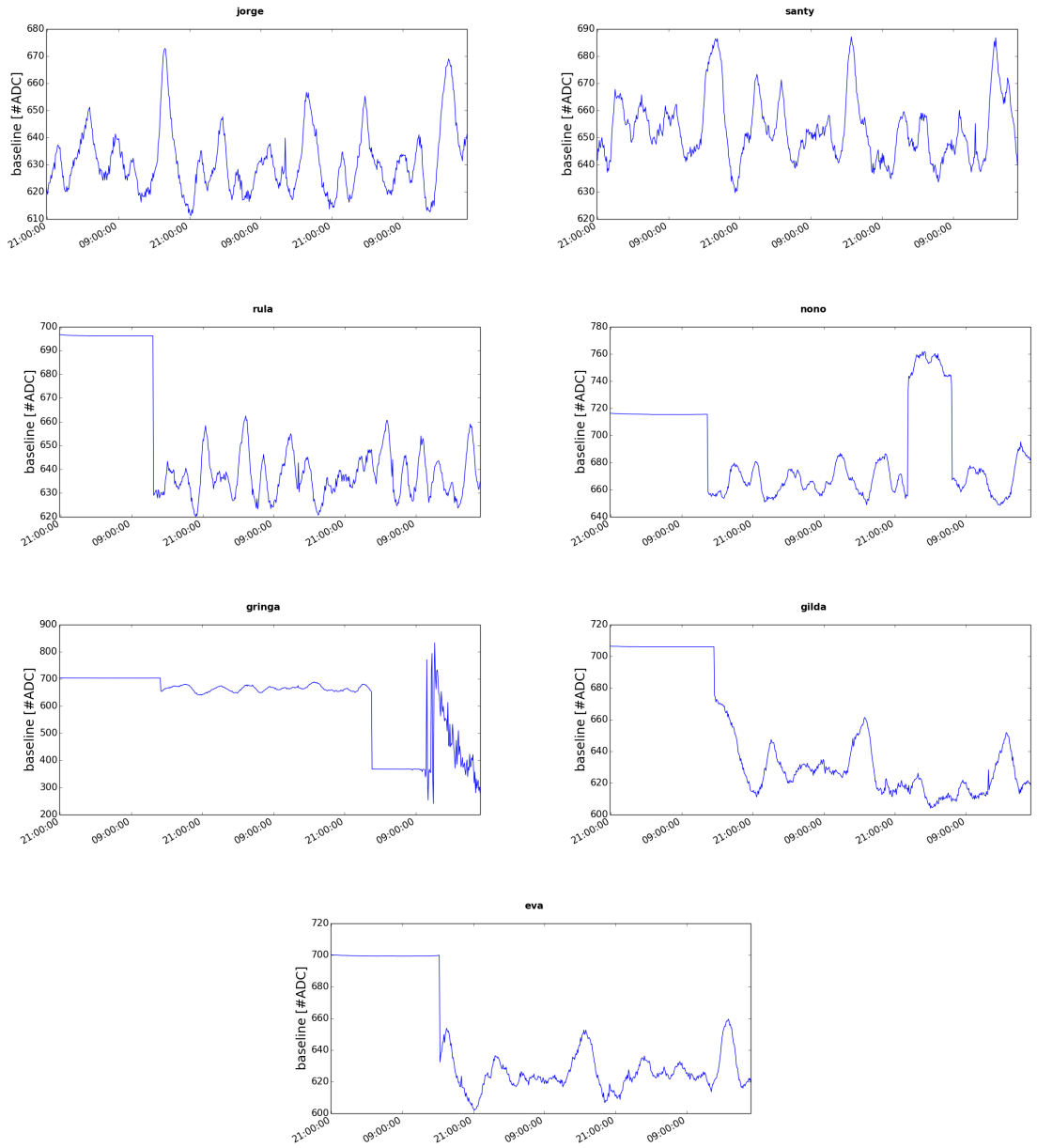

Figure 11 from top to bottom: Nono, Gringa, Gilda, Eva

4 Update

Gringa In the previous section we showed that Gringa stopped working on the 10th of the December. On the 11th we went on site and we spotted the issue: the adaptation/power distribution board was delivering 24V on the DC+RF channel instead of 5V (to supply the amplifier). We got the antenna and electronics back to the assembly building and we repaired it. (We disconnected the DC converter $M3$ and connected the V_{out} of DC converter $M2$ to the power output at the inductance $L10$ (see the electronics scheme at [4])).
From the monitoring data, it seems to work but it has to be confirmed.

Nono We also noticed that Nono seemed to be less sensitive than other antenna, especially on the sun signal. One of the possible explanation is the noise produced by the communication antenna which is just above the antenna on this tank. We modified the position of the antenna but we kept the designed orientation (see photo in the Figure 12.
From the data we collected on site and the first monitoring data, no clear improvement is observed.

Figure 12 old and new antenna position on Nono tank

Conclusion (2016/12/12)

We installed seven helix antennas with the new electronics (fixed adaptation board and new amplification system) on the hexagon initially chosen (central tank:Santy). The installation took place from the 7th of December to the 8th and went smoothly.
From the measurement taken at the installation, we could conclude that the noise floor is approximately the same for all the detectors. However some peaks are observed in the middle of our frequency band. We also observed very clearly a transient noise probably coming from the Auger communication link in at least two detectors.
All the detectors worked just after being installed. Gringa went down the 10th of December but was repaired and installed again the 12th. Nono seems less sensitive than the other antennas even after the modification of its position.
A first rough estimation of system noise temperature from the sun signal performed on Jorge yields a temperature of around 100K.

References

[1] https://atrium.in2p3.fr/nuxeo/nxdoc/default/3d986fe3-ce9b-4e1f-a84a-55389a175ef9/view_documents. 136

[2] https://atrium.in2p3.fr/nuxeo/nxdoc/default/20cbab5c-01a5-4856-af99-9045cd0659f8/view_documents. 138

[3] https://atrium.in2p3.fr/nuxeo/nxdoc/default/d5c6a4a2-c5c3-4402-887c-2bcdcf6f2f35/view_documents. 140

[4] https://atrium.in2p3.fr/nuxeo/nxdoc/default/67ebc613-fbfa-45dc-b4c6-552d843a0885/view_documents. 142