Helix detector status: May 2016

Abstract

This note presents the status of the helix detectors. At the end of May 2016 they were all removed from the field and tested in the assembly building lab. We present the status in terms of mechanics and electronics.

1 Introduction

The helix detectors were installed at the beginning of March 2015. Since then some problems arose and among the 7 installed only one seems to work properly. We removed the 7 detectors from the field, and tested some parts of them in lab.
We give in table 1 the correspondence between station name, LNA serial number, antenna number and electronics box number.

Table 1 correspondence table between detector numbers

station	Gilda	Santy	Jorge	Nono	Gringa	Eva	Rula
elec box number	11	10	09	08	05	03	02
antenna number	07	01	04	08	05	03	02
LNA serial number	022970	023232	023231	023230	022968	022967	022969

2 Mechanics

This first part reports on the state of the detectors as we found them when we removed them from the field.
All of the antennas had their metallic cone at least partly distorted. Pictures in the figure 1 show two extreme cases: Nono detector's cone (shown on the left) is distorted, in the case of Eva (shown on the right) the cone is no longer attached to the electronics box.
All the antennas are in a similar state. The mechanics has to be improved.

Figure 1 Left:Nono, Right: Eva

The second problem encountered was that water flooded inside all of the LNA boxes. Water went inside the box through the hole on top of the box (see figure 2 left). Some boxes had still 1-2 cm of water in them and rust started to grow inside the box (figure 2 right).

Figure 2 Left: helix antenna, circled the hole where water went into the LNA box. Right: rust in Santy's LNA box

3 Antenna and LNA

Here we show the characteristics of the RF parts. We show in the figure 3 the VSWR of the antennas. Jacques identified a bad contact on the antenna FPV01. All of the other antennas have a low VSWR (close to 1 in our frequency bandwidth as we expect for an impedance match).

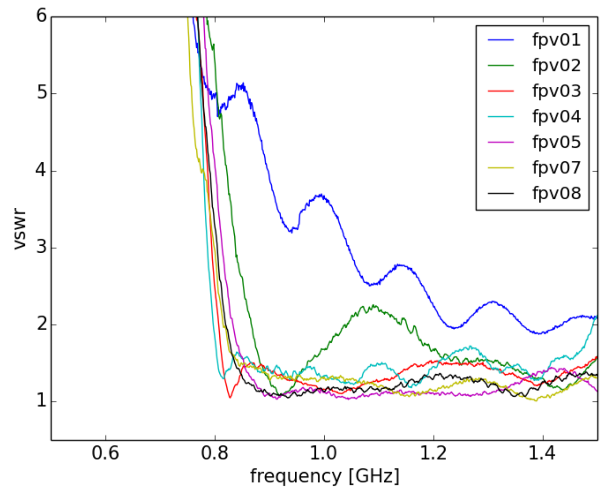

Figure 3 antenna VSWR, measured in lab

The characteristics of the LNA were also measured: the VSWR and the gain are shown in the figure 4 and 5.

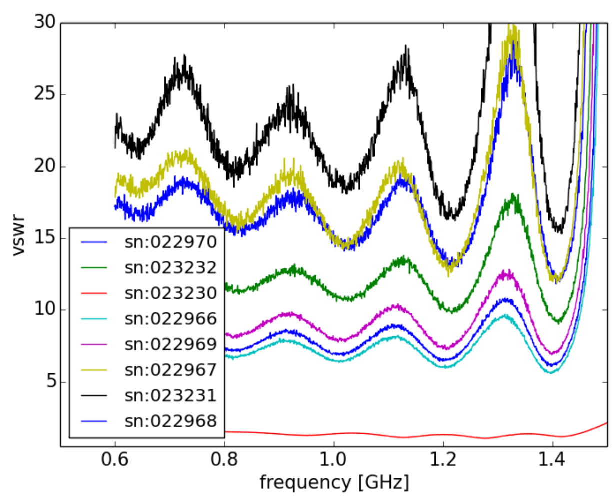

Figure 4 LNA VSWR

On the figure 5 it is clear that only one LNA is still working, the sn023230, that is the one that was installed on Nono. It has the expected gain (50dB) and a low VSWR. All of the

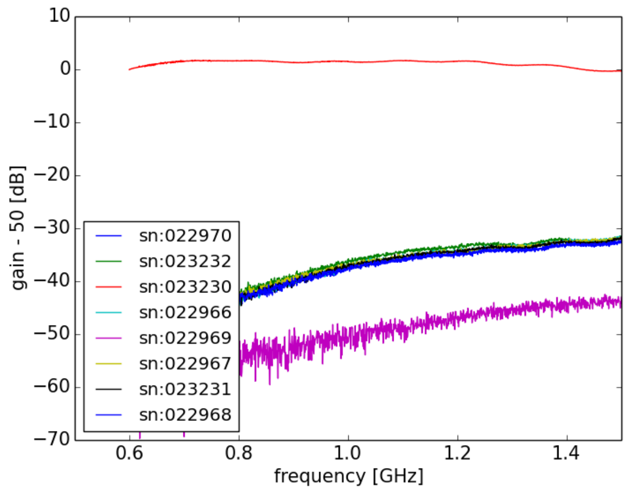

Figure 5 LNA gain. The measurement of the gain was done with a 50dB attenuator.

other ones are broken and almost all have the same characteristics.
So the LNA is the main failure of the system. The LNAs broke for an unknown reason. Possible sources of failure are:

- a power surge at the LNA input (for instance an electro static discharge or an over voltage due to a thunderstorm)
- the humid/water environment (for instance if the LNA was flooded inside the box)

A possible solution to the power surge could be to install a transformer (with coil), or a diode system before the LNA. We need to evaluate the effect of these devices on the noise figure (since they need to be placed before the LNA).

4 electronic box

The last part of the detector is the electronic box. They were installed under the SD electronics dome, and they were found in good shape. None of them suffered from an obvious problem. We tested them with the setup shown in the figure 6. This setup allows us to compare all the

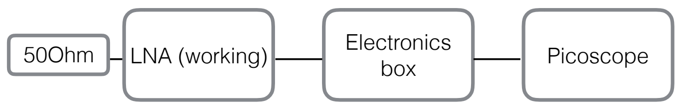

Figure 6 setup to evaluate the electronics box characteristics. The LNA and the load are installed in a LNA box with an antenna over it, but the antenna is NOT connected.

boxes with the same reference, i.e. 300K of the 50Ohm load. We acquire data (10 waveforms) with the Picosope (4MS/s, 2ms/div) for each box. The mean and standard deviation are reported in the table 2. (reminder: after the box 100mV=1dB)

Table 2 average and RMS measurement of the electronics boxes

box number	11	10	09	08	05	04	03	02	06
station	Gilda	Santy	Jorge	Nono	Gringa	-	Eva	Rula	-
average (baseline)[mV]	-469	-291	-270	-477	-305	-548	-450	-445	-774
standard dev [mV]	47	97	40	86	52	83	58	43	50

notes at data taking

- box 09: baseline varies with time ($\simeq$ 1mV/min)
- box 08: remeasured at $average = -438mV$ and $\sigma = 60mV$
- box 04: has peaks every 10ms
- box 03: baseline varies with time ($\simeq$ 1.5mV/min)
- box 02: baseline varies with time (from -430 to -443 in the first minute, -445 after two minutes)
- box 06: has peaks every 10ms

remarks

1. One can see that the baselines are quite different, this of course depends on how much was rotated the adjustable resistor. However when we look at the installation sheet, for four detectors (Gilda, Santy, Eva, and Rula) the baseline was not changed at the installation, that means we can directly compare the average values in the table 2. We see that Eva, Rula and Gilda differ by less than 0.2dB, but Santy's baseline differs by around 150 mV (1.5dB).

2. A second remark is about the RMS, one can see two populations: one around 50mV and one around 90mV. This is strange because the RMS should not depend on the adjustable resistor settings, it should be approximately the same for all the boxes because the input is the same. This problem has to be investigated because the RMS should be a direct measurement of the input noise, so a difference of a factor 2 is worrying.

3. Two boxes (number 4 and number 6) showed peaks with a 10ms period (cf fig 7). We still don't know where this noise comes from. We sometimes saw it and then it disappeared, its amplitude was also changed by the orientation of the box (containing the LNA and the 50Ohm load). It could be an anthropic signal captured by the antenna or some part of the box (the assembly building is very noisy at these frequencies).

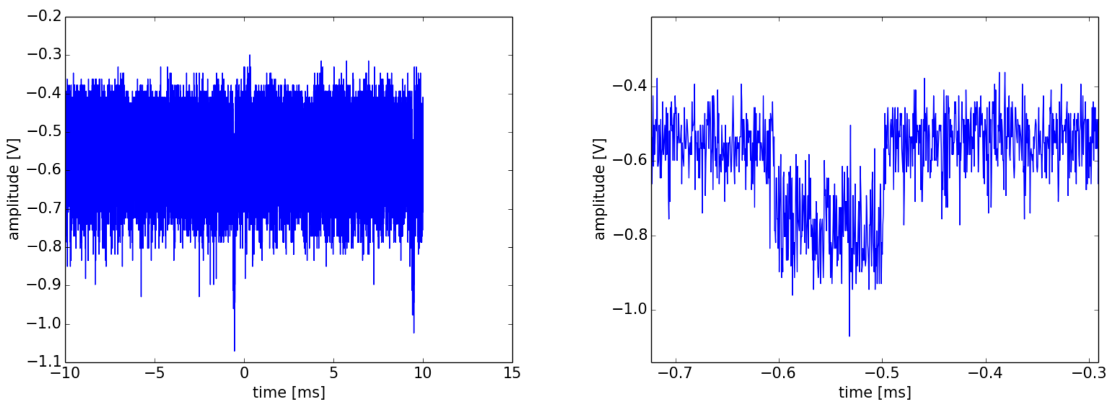

Figure 7 example of trace of the box 4 (left) and zoomed (right)

4. As for the time varying baseline, this could be explained by the warm up time of the electronics. Mari did a longer measurement of box9. The results are plotted in the fig 8, the baseline drops by a few tens of mV in 30 minutes. The decrease rate gets smaller with time (the derivative gets close to zero).

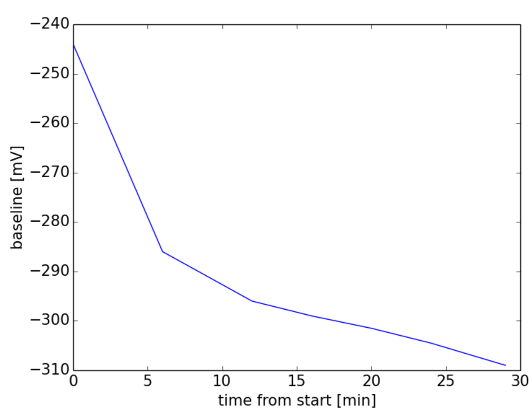

Figure 8 baseline versus time for the box number 9

5 conclusions

- all the cones around the antenna were damaged, it is being repaired and strengthened by soldering again the cone base (the larger diameter of the cone) and attaching ropes from the antenna to the cone base.
- the hole in the LNA box let the water enter and has to be filled (done with silicon gel)
- most of the LNAs are broken, the cause of this failure is not known yet. We should anyway look for a protection against electrostatic discharge.
- some electronics boxes show behavior that is not understood (different RMS, variation with time). We will continue the measurement and potentially bring back some boxes to France.