

Checking noise traces for NIKA2

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checkingNoiseSpectra_v2.pdf

Version 2

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1 Introduction

The noise traces of NIKA2 KID detectors are the first tool that can be used to spot the onset of problems in the alignment of NIKA2 Pulse Tube (PT) head. Furthermore, they are more in general a useful tool to check the overall sanity of the system. This manual describes how to get such noise spectra and gives a few samples of traces that can give an idea of what to expect. Notice though that we assume, for simplicity, that the system is already up and running (as it is in general the case during the runs).

Another important note is that, before gaining enough experience, correctly interpreting the noise traces can be sometimes tricky. So, if you think you have spotted a problem, please **contact a member of the NIKA2 team to confirm your findings!**

2 Checking the noise

To check the noise, connect to the 'Mac12' computer (the one on the right on the NIKA2 desks in the center of the control room). The name is marked on the screen. It is usually always on, but in case, the username is 'arheops' and the password the standard of the NIKA2 computers. The *lecture* and *trace* programs (see figure 1 should already be running. If this is the case, proceed to section 2.2. If not, follow the steps of next section.

2.1 Launching the *trace* program

In the screen of Mac12, click on the green frog icon on the top of the program bar (situated on the left of the screen). This program is called *lecture*, and opens a green window. In this window, you should have the name of the current scan blinking, and a green button saying 'synchro ok'. On the right, some lines should be scrolling by. If any of these conditions is not met, contact a NIKA2 team member.

Once *lecture* is running, you can launch the second needed program, *trace*. To do this, click on the orange elephant icon, just below the green frog. This will open a small orange window, where you should see the name of the current run blinking. Now, open a window to plot the KID traces, and follow the steps described in page 4.

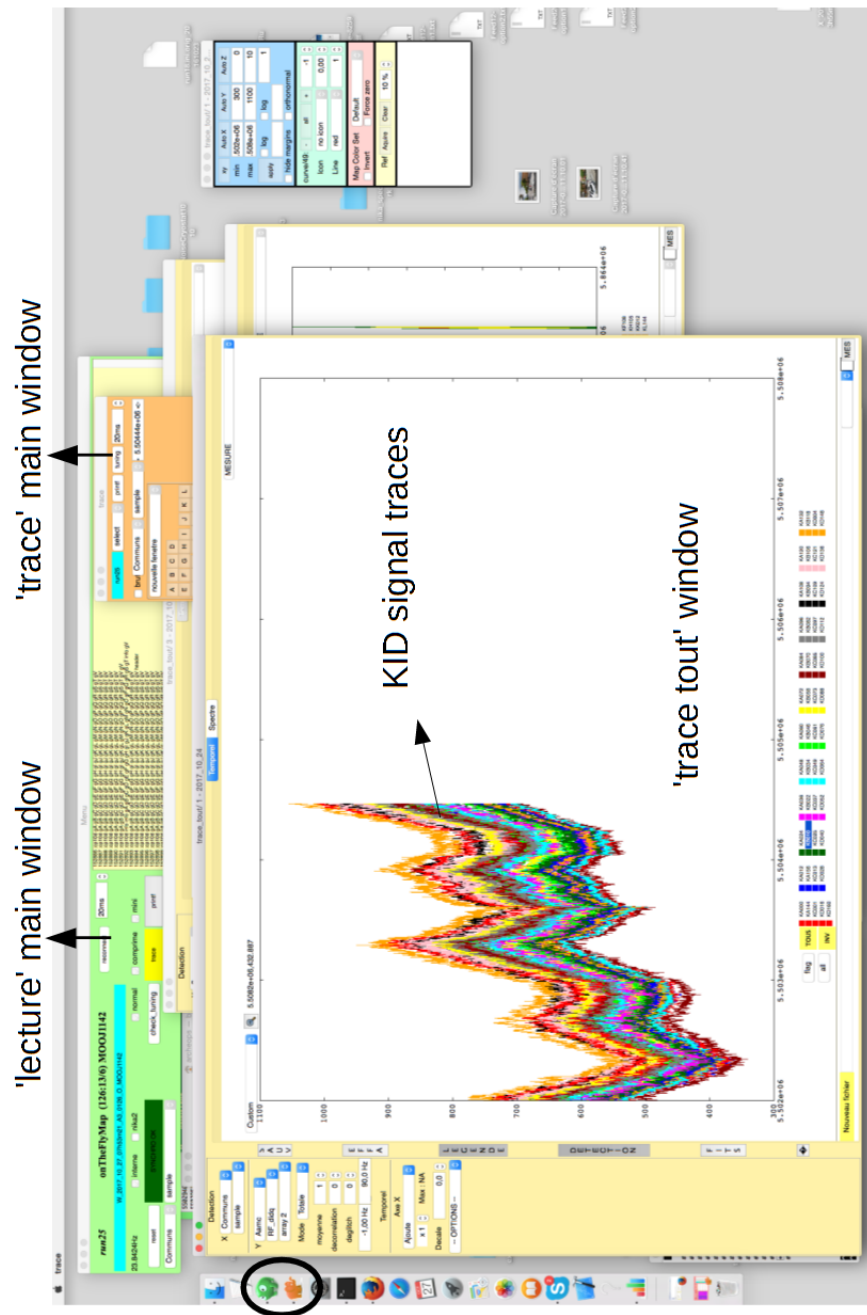


Figure 1: Image of the Mac12 screen, with the *lecture* and *trace* window open, and a plot of KID time traces. The icons to launch *lecture* and *trace* are encircled in black.

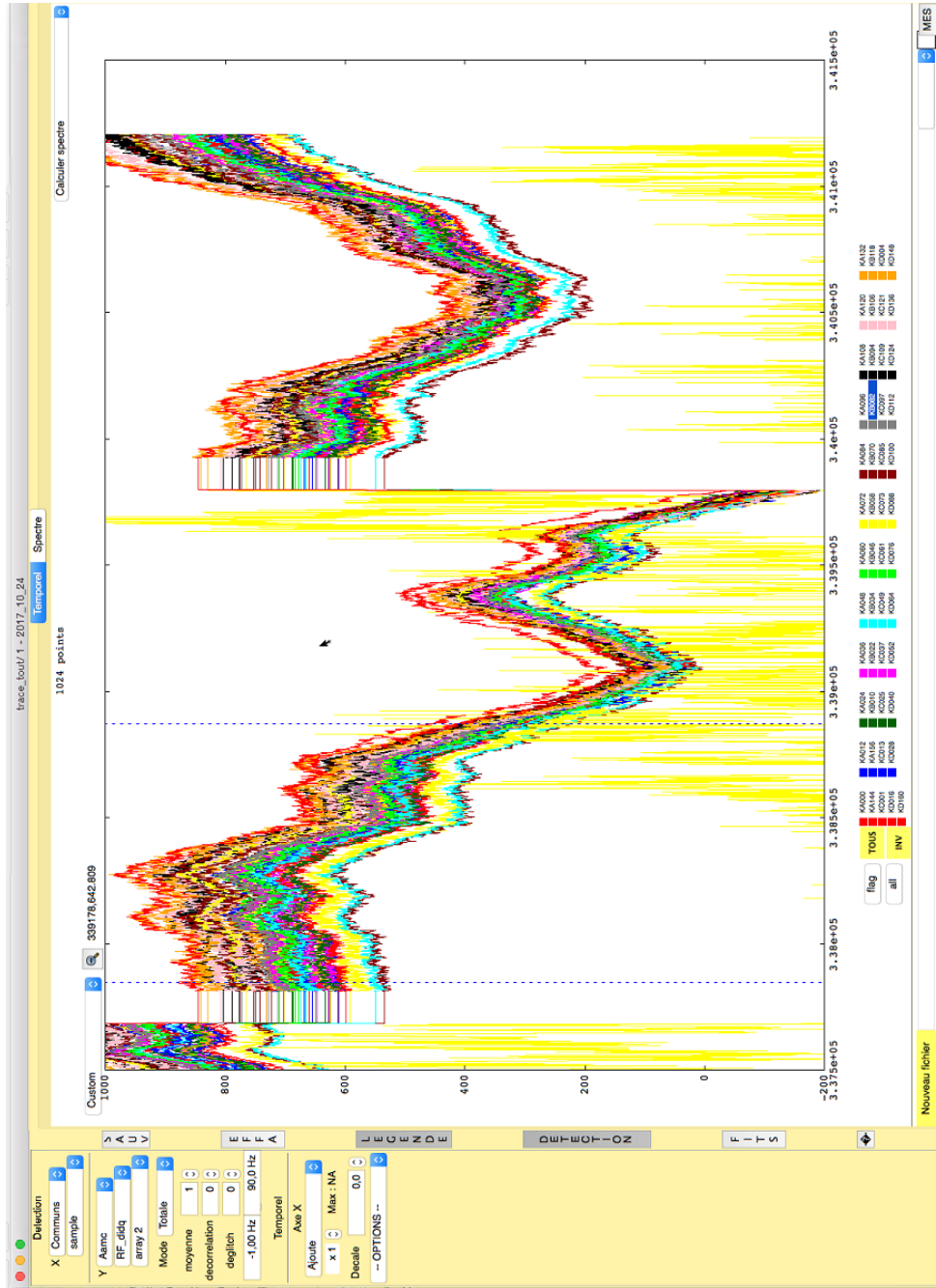


Figure 2: Zoom on the 'trace tout' window. The vertical dotted lines indicated the beginning and en of the data that will be used for the noise spectrum. On the top of the window it can be seen the number of points that will be used (1024 in this case). The part of the time traces where you can see perfectly horizontal lines must **NOT** be used for taking spectra! (These are masked data, associated to the system tuning of the detectors).

1. On the orange *trace* window click on 'nouvelle fenetre' and choose, in the drop down menu, 'trace_tout'.
2. In the window that opens (see figure 2 for a zoom on it), click on 'detection' (on the left).
3. A new part of the window appears on the left. Here, click on the drop down menu for the 'Y' axis, where it says 'Communs', and choose 'Aamc'.
4. In the drop down menu just below it, choose 'RFdIdQ', in the the following one, where it says 'kidA', choose 'array2'
5. In the drop down menu below 'axe X' choose 'ajoute'.
6. Click on the 'legende' button
7. Write '-1' in the small text window *below* to where it says 'deglitch' (the one that, by default, says '0,00Hz'), and press enter.
8. Click in the 'effa' button.
9. Now, double-click on the Y axis bar, then on the X axis bar.
10. Done! You should see the time traces of the KIDs scrolling by!

2.2 Taking noise spectra

If the windows of *lecture* and *trace* are already open, you can proceed to taking noise spectra. First, check that the traces of the KIDs are visible in the *trace* window (figure 2). If not, it is maybe because their resonances have drifted away. Repeat the steps 6 to 9 in the previous section to recover them. Now, wait sometime (say, 1 minute). Then, once you have enough samples on the plot, you can take a noise spectral trace:

To take a noise trace, click 's' on the keyboard (for 'spectrum'). Then, click with the mouse in the KID traces plot to choose the starting point of the data used for the evaluating the noise, and click a second time to choose the end of the data used. If you don't see the noise spectrum in the plot, double click on the Y and X axes to autoscale it.

The program always uses a number of point that is a power of 2. Use at least 512, better 1024 (or more!) points for the noise spectra!

After choosing the range of data used, *trace* evaluates the spectrum and plots it. To calculate the noise spectrum, a Fourier Transform is applied to the data, thus allowing to find how much noise there is at the different frequencies. You can zoom on a selected part of the graph by clicking and dragging with the mouse on the plot area of interest.

To take a different spectrum, go back to the KID time traces plot by clicking the 'temporel' button above the plot area. You can then restart the procedure described above.

3 Interpreting noise traces

Here you can find a few guidelines to understand, looking at the noise spectra, if the noise level is good, average, or bad. Notice though that the the situation of the NIKA2 instrument at the moment of data taking (observing or not? what kind of atmosphere? etc..) has a big impact on the noise you'll see.

3.1 Recommendation for taking noise traces

There are 2 main cases that will be common: ongoing NIKA2 observation, or NIKA2 stopped, and window of the cryostat closed (must be well closed! With the aluminium disc installed and alu tape to scotch it to the cryostat and prevent light from getting inside through the sides of the disc).

- **If the window of the cryostat is closed** and no NIKA2 observations are ongoing: you can take your noise spectra without worries. The atmosphere, or more in general the optical power incident on the detectors, will not affect your measurement. In this case you should find a pretty flat spectrum (see for an example figure 6).
- **If NIKA2 observations are ongoing:** in this case, clearly, the window of the cryostat will be open, and light will be shining on the detectors, causing a signal. Thus, the time traces of the KIDs will be affected at the same time by all noise sources internal to the cryostat (detector noise, PT vibrations if any, amplifiers...) *and* by the signal of the atmospheric emission and of the source being observed. *So the resulting noise trace will be the sum of many components.* To try to get the most information about the noise sources internal to the cryostat (including the PT), which are the ones we are interested in, you should:
 1. Avoid taking noise spectra during observation on bright sources (calibrators, pointing sources, planets..)
 2. If possible, try to take data in a moment in which the antenna is actually stopped. If observation are ongoing, wait for the end of the scan(s) in the queue and ask the observers to wait the needed time before new scans are launched.
 3. On the time traces, try to select the range of the data in which the KID are more stable: their trace should be as flat as possible, without big jumps, rapid increases or decreases, and so on. Notice that if the weather is not very good or the atmosphere is very agitated, it might be difficult. In this case, take the spectra in any case but be advised that the atmospheric contribution might be dominant.

3.2 Examples of typical noise traces: window closed

In the following pages you can find sample noise traces corresponding to various typical cases, taken with the window closed, to better highlight the effect of the PTs, and to show the difference of a PT2 (worse) or PT1 (a bit better) touch.

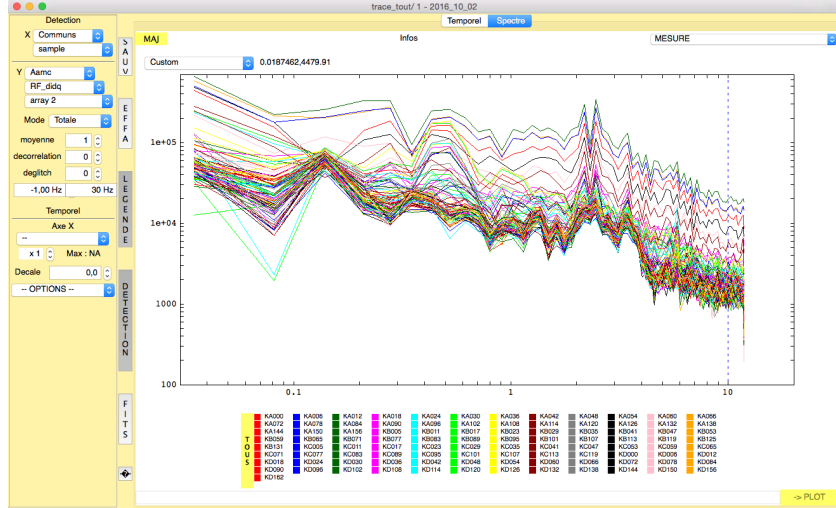


Figure 3: Sample noise spectra calculated by *trace*. Each trace is the power spectral density of the signal of one KID, obtained applying a Fourier Transform to its time trace. The Y units are $\text{mHz}/\sqrt{(\text{Hz})}$, and the X units are Hz. The case presented here is an example of a really bad condition, with the PT2 strongly touching the 4K plate. You can see a big 'bump' on the spectrum that increases the noise level by a factor 10 or more. If the situation is so bad, it will be possible to notice it even during observations. **Contact the NIKA2 team!**

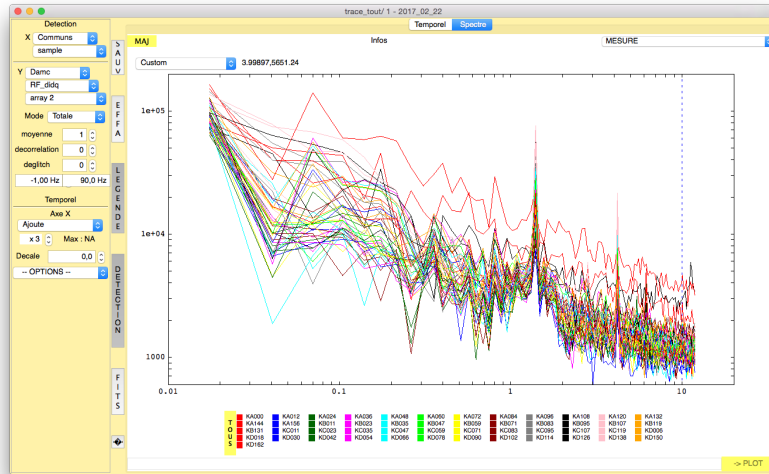


Figure 4: Noise traces in a slightly better but still bad situation. In this case you can see some peaks in the noise spectra at the PT frequency ($\sim 1.4\text{Hz}$) and its harmonics, plus a small bump on the spectrum. It's probably a good idea to improve the PT2 alignment: **contact the NIKA2 team** for confirmation!

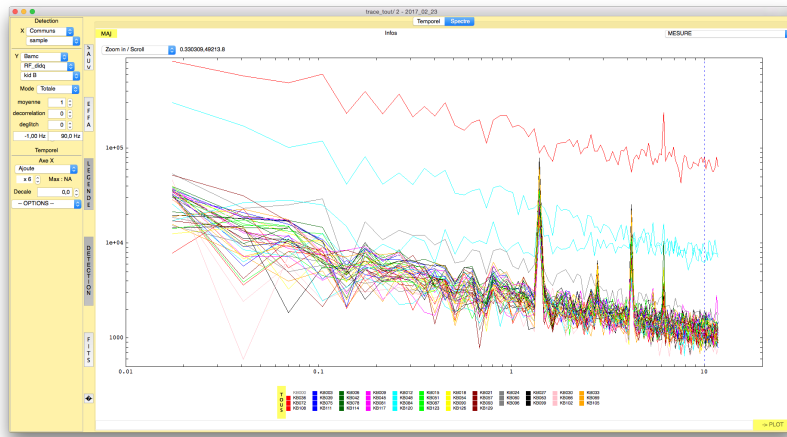


Figure 5: Noise traces in an almost (but not completely) good situation. The 'bump' due to the vibrations has disappeared but some lines/peaks in the noise spectra are still visible at the PT frequencies. The PT2 is probably still very lightly touching. This is in any case an almost acceptable configuration (or acceptable, if it's impossible to do better). Discuss with the NIKA2 team and/or the observers to decide what to do.

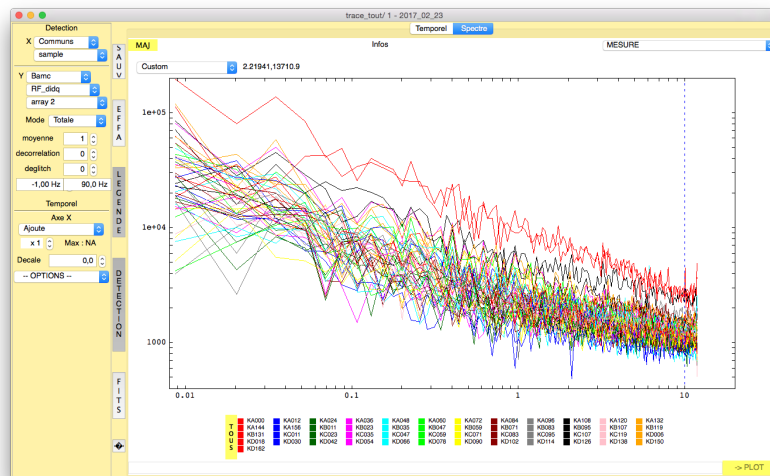


Figure 6: Noise traces in a good configuration: the PT is in this case NOT touching, so you can observe! Note how the noise spectrum is flat, its level is at around 1000–2000, increasing a bit at low frequency. Sometimes a peak in the noise is observed between 6 and 10Hz: its origin is not yet understood but it doesn't have a major impact on the data, and is any case not related to the PT.

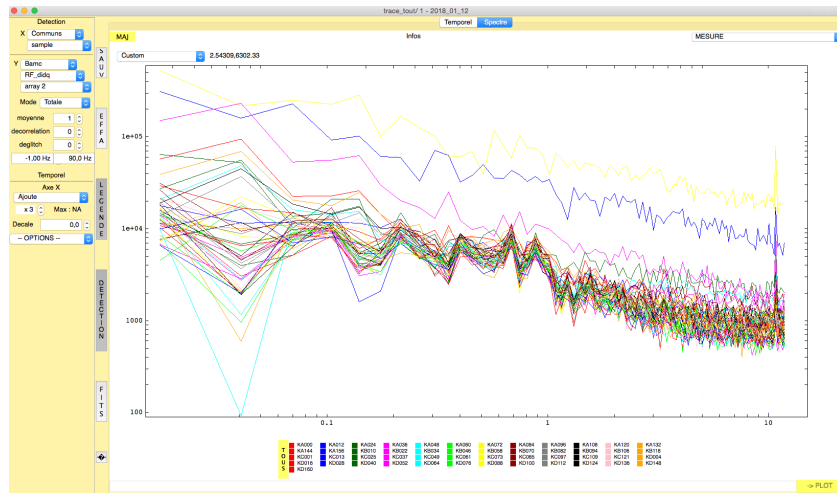


Figure 7: Noise traces with the PT1 touching a bit, while the PT2 is well aligned. Notice that no peaks at 1.4Hz can be seen (those are due to PT2). The noise 'bump' is also less pronounced than when it's due to PT2 (compare with figure 8): the level is now lower, and it also rolls off at a lower frequency (2Hz). Discuss with the NIKA2 team and/or the observers to decide what to do, and if you decide to intervene, first try to adjust the PT1 position.

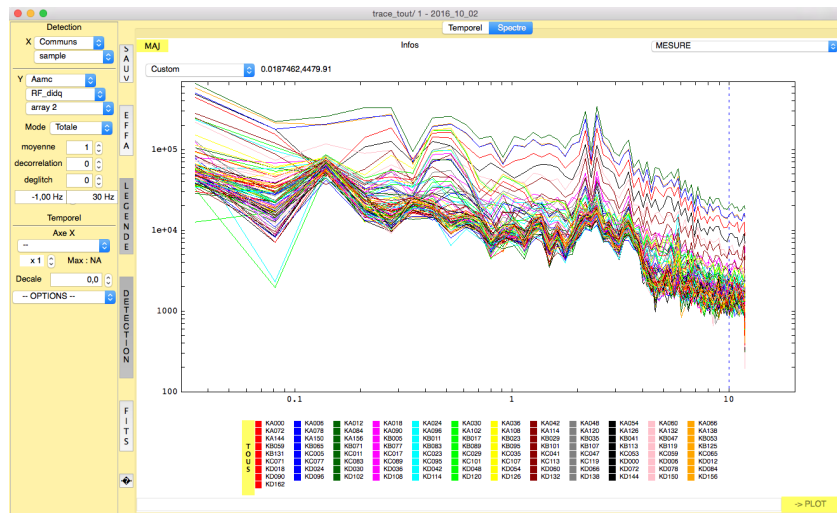


Figure 8: Same noise spectrum already shown in figure 3, replicated here for ease of comparison with the previous figure. Notice the difference between the noise spectra when PT2 is touching (this image) wrt PT1 touching (above).

3.3 Examples of typical noise traces: window open

Here you find some sample spectra taken during observation, and therefore with the atmospheric contribution present (at different levels depending on the weather conditions).

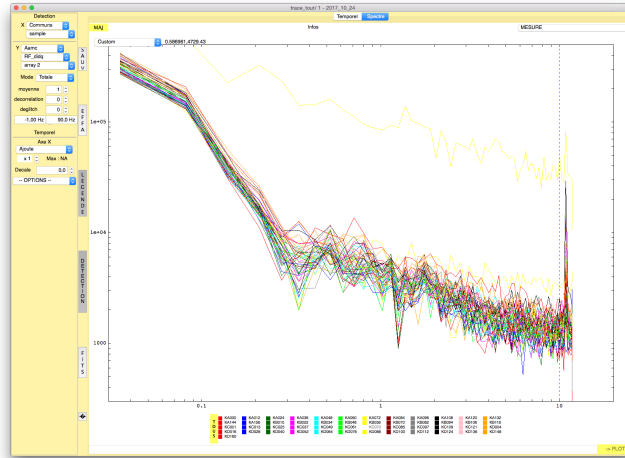


Figure 9: Noise with the PT well, but not perfectly, aligned. You can spot a sort of small 'bump' around 1Hz, although not very strong. The noise increase at low frequencies is due to the atmosphere, *not* to the PT! Both the atmosphere and the PT are likely to be contributing to the noise at around 1Hz.



Figure 10: Similar situation: PT almost ok but not perfect. You can in this case see a (small) peak at around 1.3Hz, the frequency at which the PT works.

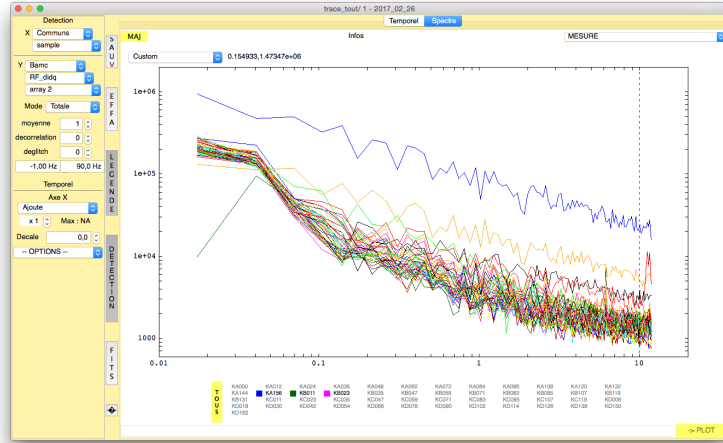


Figure 11: Noise traces with the PT perfectly aligned (no particular structure can be seen at around 1Hz), looking at a pretty stable sky. The noise level increases at low frequencies due to the atmospheric fluctuations.

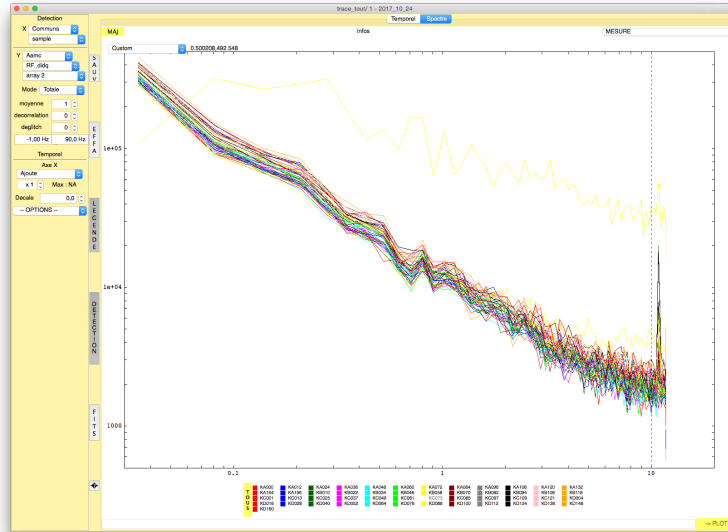


Figure 12: Noise traces with, looking at an unstable sky. The noise level due to the atmospheric fluctuations is very strong, and is the only feature that can be seen. The PT noise, if it's not very strong, would in this case be hidden by the effect of the atmosphere.

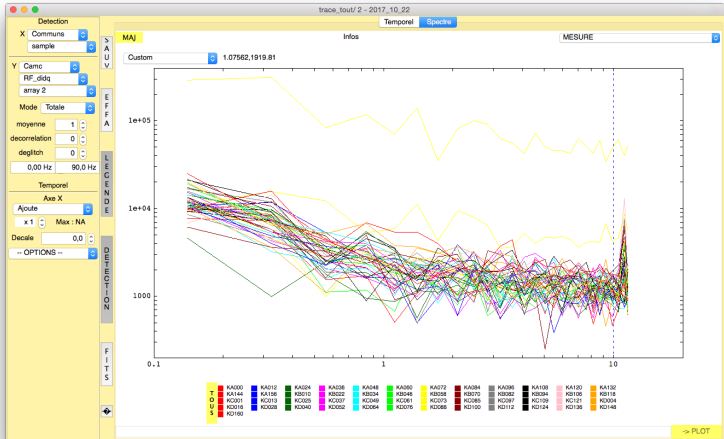


Figure 13: This represents **the ideal situation**: this spectrum was taken looking at a very clear sky. The atmosphere was very stable and very transparent (tau was 0.1). Furthermore, the PT was perfectly aligned, as no noise increases are observed around 1Hz.