Noise comparison between two different types of sensor installation

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Observatoire de Grenoble broadband seismic network modernization and improvement : Noise comparison between two different types of sensor installation.

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[1] ISTerre-UMR-5275

RISE : *Réseaux Intégrés de Surveillance Sismologiques et d'Échange(projet Alcotra 2009-2011)*
RESIF : *Réseau Sismologique et Géodésique Français*
INTERREG : *Iniative communautaire du FEDER (fonds Européen de développement régional)*
ALCOTRA : *Alpes Latines Coopération TRAnsfrontalière*
RAP : *Réseau Accélérométrique Permanent*
RLBP : *Réseau Large Bande Permanent*
RENAG : *REseau National GPS permanent*
OMIV : *Observatoire Multidisciplinaire des Instabilités de Versants*
OCA : *Observatoire de la côte d'azur*
DIPTERIS/RSNI : *Dipartimento per lo Studio del Territorio e delle sue Risorse / Regional Seismic network of Northwestern Italy*

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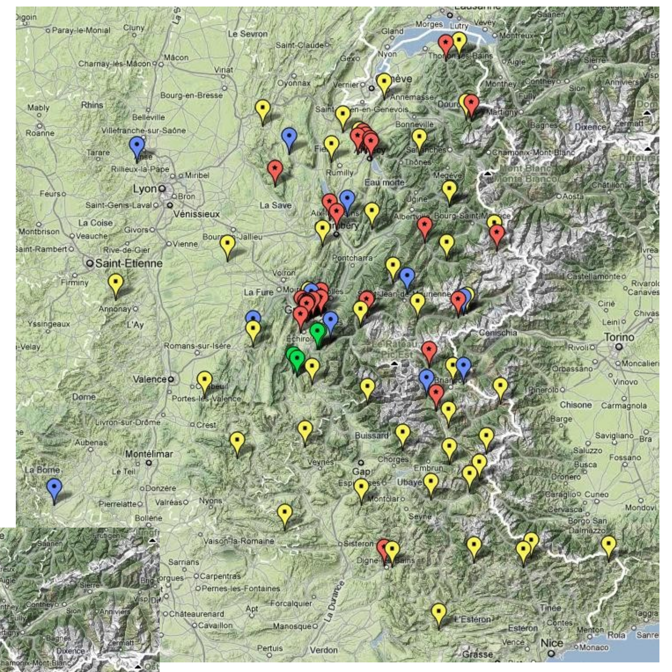
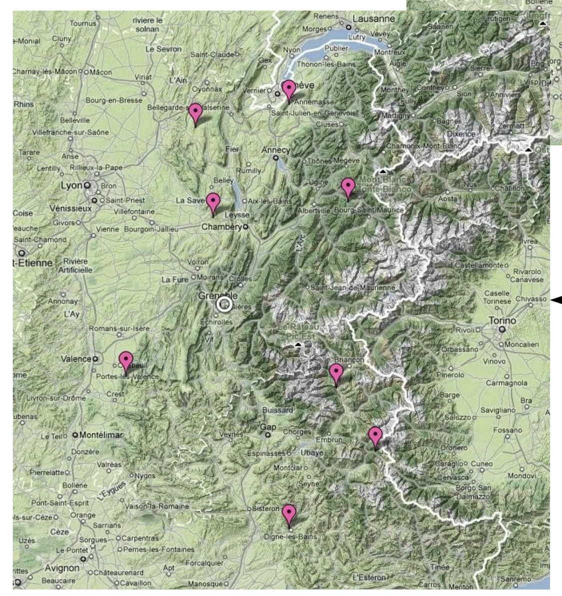
OSUG/ISTERRE Permanent Network : 1

The "Observatoire de Grenoble" (OSUG) is in charge of 99 permanents seismic/geodetic sites in the northern French Alps.

- *: 33 RAP*
- *: 44 Sismalp-RLBP (SP & BB)*
- *: 16 GPS-RENAG*
- *: 6 OMIV*





The Interreg/Alcotra RISE Project (2009-2011) aims at installing eight up-to-date BB+SM+GPS sites.

Broadband seismic network modernization : 2

Reorganizing and upgrading real-time, continuous shared sites.

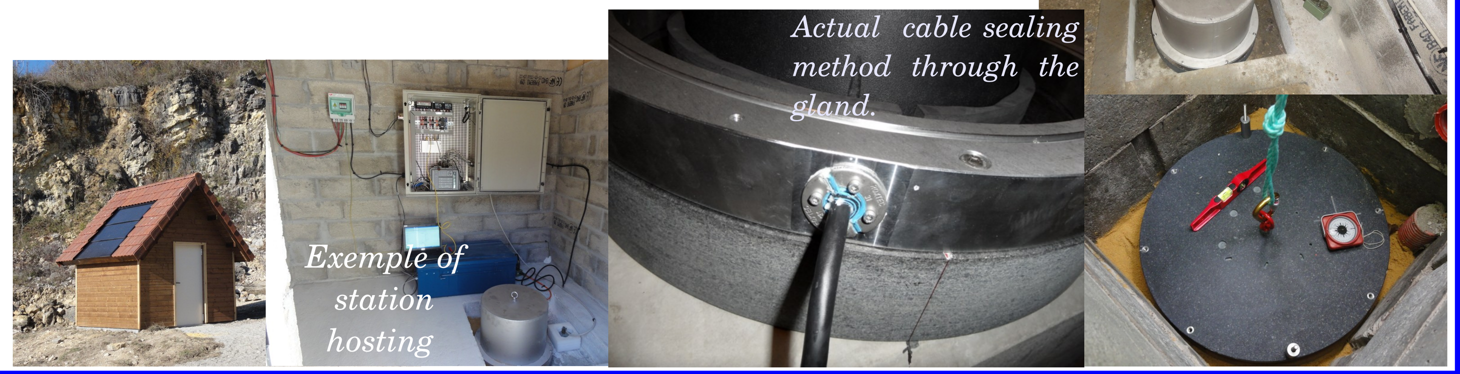
The instrumentation of each 8 sites is based on :

- *High performance 6 channels digitizers (Kephren_BB – Agecodagis)*
- *BroadBand velocimeter (T240 & T120PA by Nanometrics or STS-2 by Streckeisen)*
- *Strong-Motion accelerometer (FBA-EST by Kinemetrics)*
- *TCP/IP connection for data transmission and telemetry (ADSL, RNIS, EDGE, UMTS, HSDPA...)*

Two sites also host a GPS-RENAG station.

To fulfill the high quality standard defined by the scope of RESIF we also install :

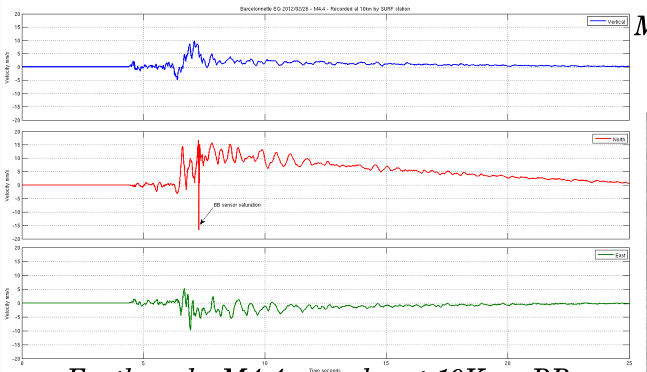
- *thermal and barometric insulation for the BB*
- *electrical and lightning protection*
- *environmental monitoring of the station (battery voltage, AC power, temperature, pressure, remote control of power supply...)*



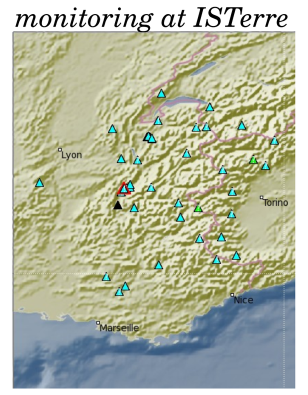
Real-time monitoring : 3

The new instruments deployed transmit continuous real-time seismological data using the « Seedlink » protocol to gather and share data flow with other observatories (OCA, Geoscope, DIPTERIS...). These signals are used at ISTerre for data quality control and seismic event detection.

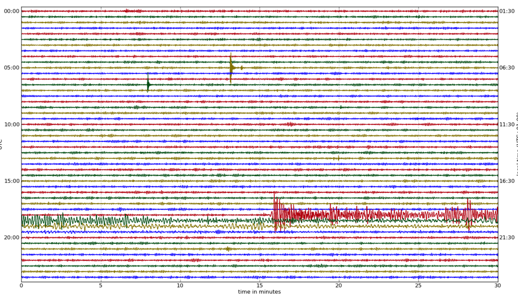
The network is also monitored using dedicated softwares/scripts (Seiscomp3, Earthworm, Nagios, Python, Matlab & bash scripts...)



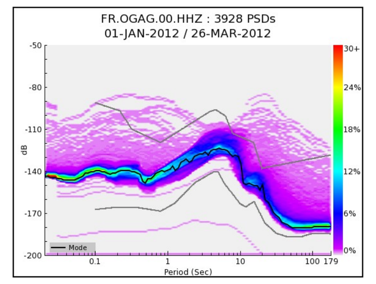
Earthquake M4.4 recorder at 10Km : BB saturation (due to tilt?), full waveform thanks to the co-located SM



Map of the stations used for local seismicity monitoring at ISTerre

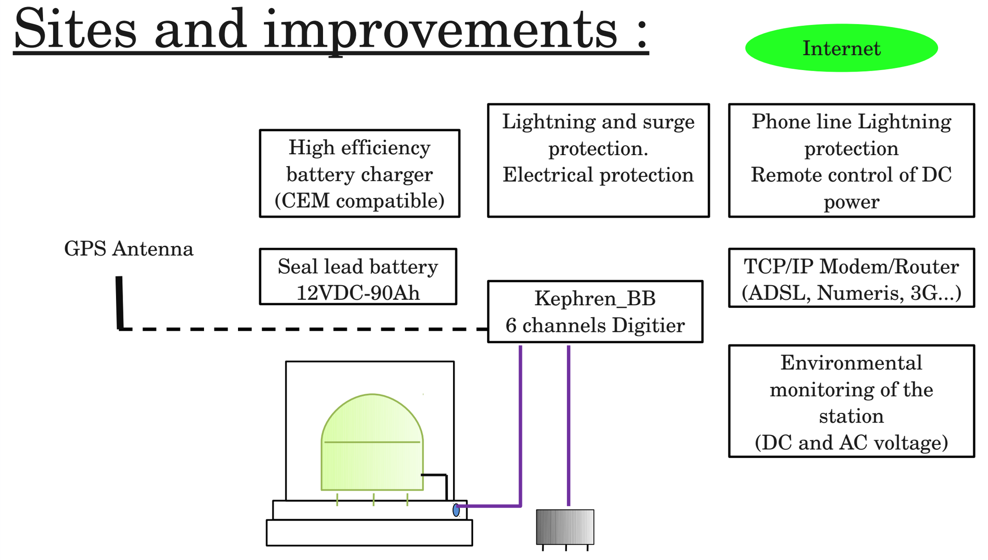


Local and tele-seismic events



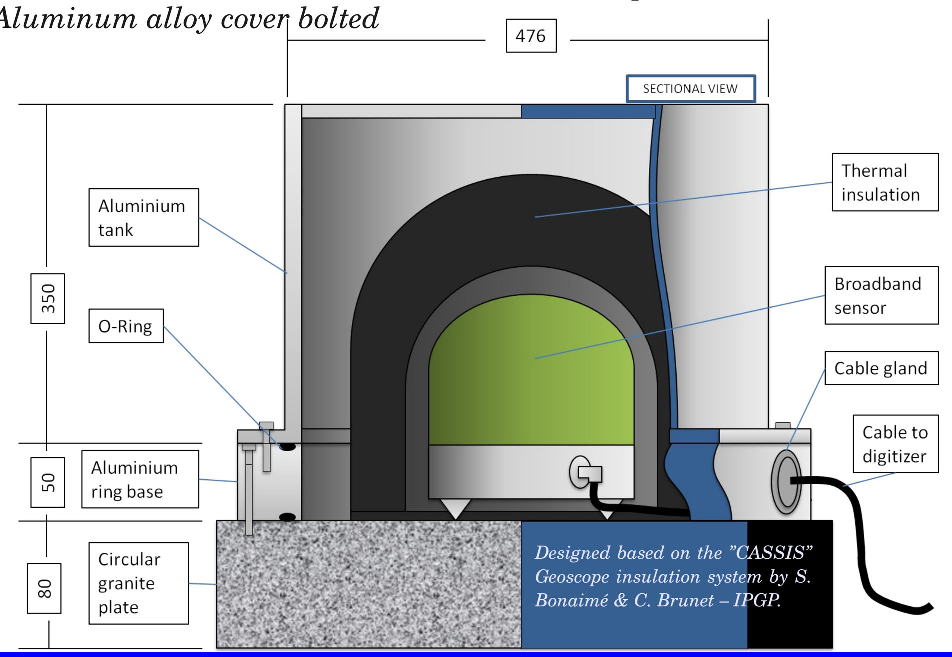
PSD estimation with PQLx

Sites and improvements : 4



Barometric and thermal insulation for broadband sensors:

- *Pressure insulation*
- *Thermal insulation*
- *Aluminum alloy cover bolted*
- *Sealed assembling*
- *Granite plate*



Aluminum alloy cover bolted on granite plate : The TANK 5

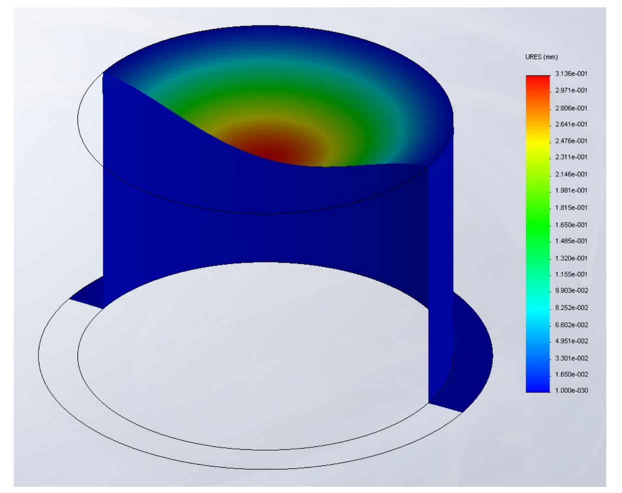
Test of the efficiency of the pressure insulation :

A- numerical simulation of the deformation due to pressure

B- quick pressure variation response

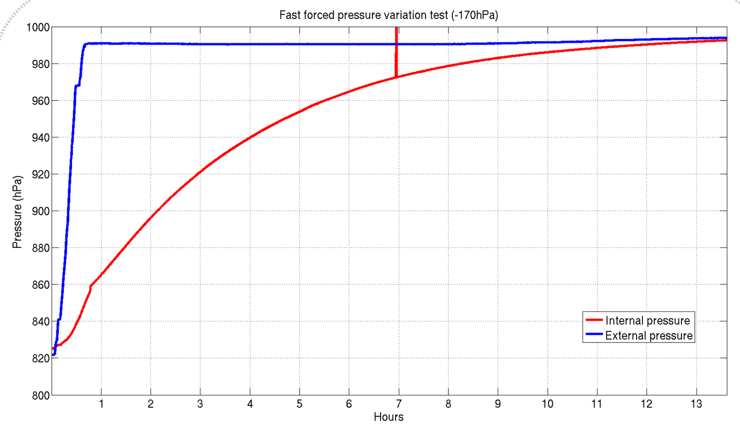
C- natural pressure variation response

- *For the "A" method we use the software SolidWorks to study the mechanical response of the TANK to the air pressure.*
- *For the "B" method the tank undergoes a rapid barometric falls (from the mountains down-to Grenoble City : -1500m). We observe the pressure leakage measuring the internal and external pressure.*
- *For the "C" method we leave the tank installed during 4 days in a "stable" thermal room, observing the inside and outside pressure variation.*



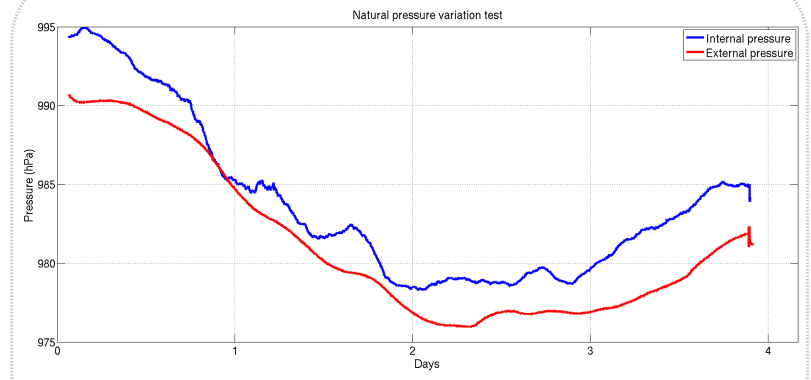
"A" results :

We simulate a +25hPa variation of the external pressure keeping the temperature constant. We calculate the deformation of the cover bolted : 0.316 mm. Without leakage, this deformation would induce an internal over-pressure of 0.466hPa. So the cover reduces the pressure effect by a factor of 55. This should be true in the case of a perfect sealed installation, and without any thermal variation.



"B" results :

The pressure leakage time constant can be estimated to 4 hours.
The system is not air-tight but should filter hourly pressure variations



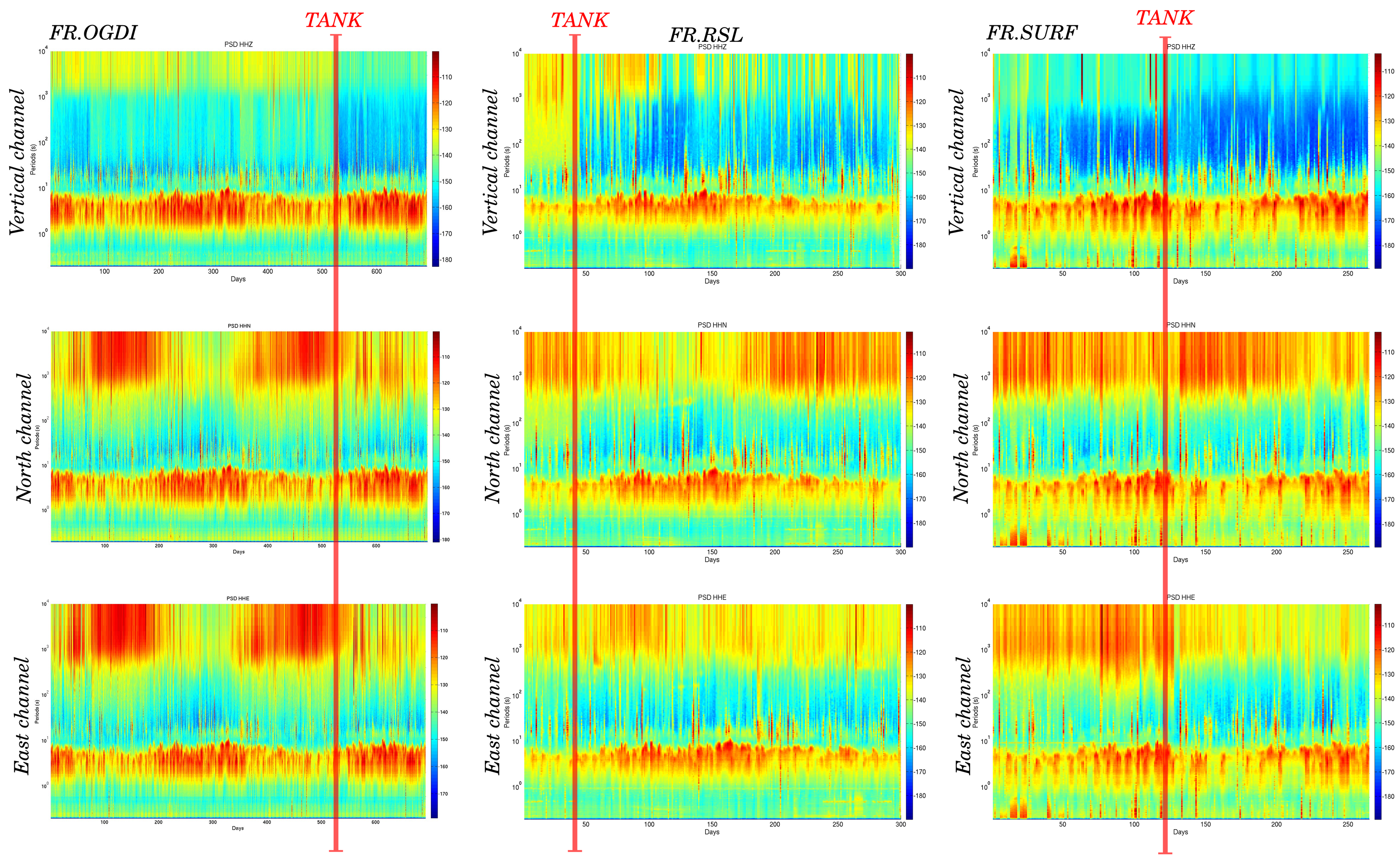
"C" results :

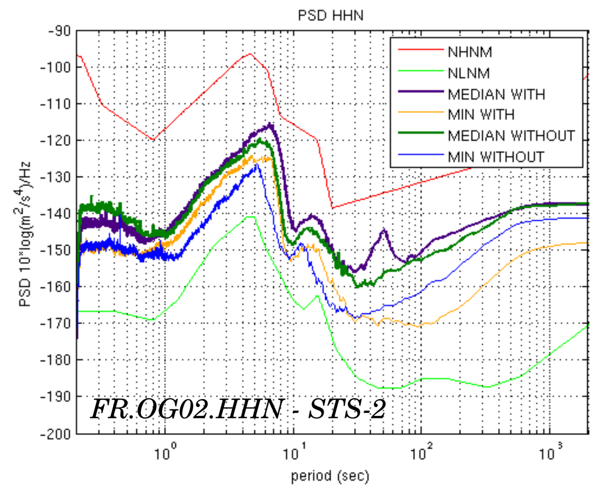
The outside pressure variations are low-pass filtered by the TANK. The long period variations are not filtered, because air tightness of the TANK is not achieved. But faster pressure variations (few hours) are filtered by the TANK. To improve the system we have to rework the sealing of the cable through the gland.

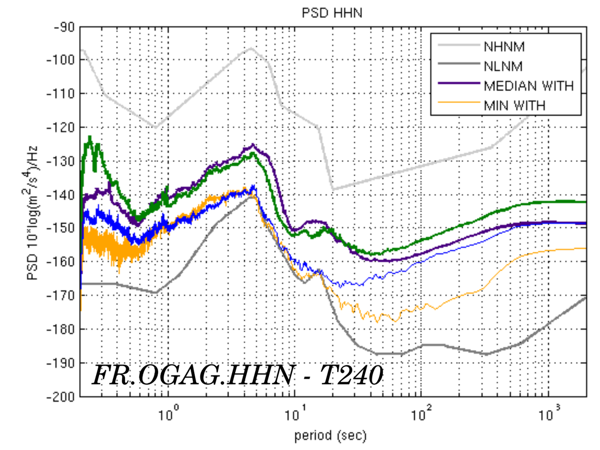
Noise comparison of the effect of the TANK : 6

We evaluate the benefit of the TANK by comparing the data recorded before and after the installation of this barometric/thermal insulation. This comparison has been achieved for 5 different stations, over at least one year of data. The period of observation without and with the insulation are different for each site. We present here some relevant results.

The three steps of the analysis :
- *conversion from mseed+dataless in SAC format (RDSEED)*
- *deconvolution of the instrumental response to acceleration and decimation (SAC)*
- *Power Spectral Density (Welch estimation) and plotting (MATLAB)*







These figures show the efficiency of the TANK on the noise reduction for periods greater than 20seconds.

Conclusions : 7

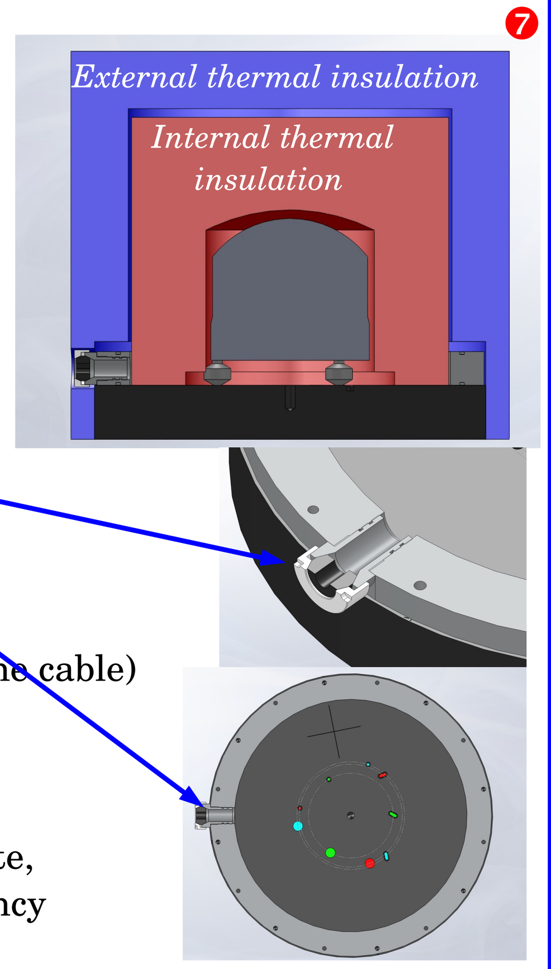
The benefit of the TANK is evident. Above 20s we have shown that the noise reduction is efficient over each channels from 5 to 20dB for the different stations analyzed. We consider that the improvement is mainly due to :

1- thermal insulation : smaller air volume and so less temperature fluctuation around the sensor.

2- barometric insulation : the tanks acts as an low-pass filter to the pressure variations (few hours)

3- general improvement of the sensor installation (granite plate, cable installation...)

We plan to go forward by designing dedicated internal and external thermal insulation (machined polyurethane foam), to improve the rigidity of the cover bolt, and to upgrade the gland for the cable with an air-tight system through the ring (figures on the right).



The advantages of the TANK design are :
- compatibility with at least three BB sensors types.
- the mechanical assembly using an aluminum ring (easy to install, no extra connector for the sensor, no putting to seal the cable)
- the aluminum cover bold design (nonmagnetic, cost reduction in series)
- the granite plate design (easy orientation for multiple BB sensors, stable and clean surface)

Our general feedback is that thanks to the improvement and modernization applied to our BB sites (installation up to date, continuous monitoring, real time transmission) we have increased both the quality of the signals recorded and the efficiency of our seismic network.