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# Designing a low-cost effective network for monitoring large scale regional seismicity in a soft-soil region (Alsace, France)

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## ABSTRACT

The Seismological Observatory of the North-East of France (ObsNEF) is developing its monitoring network within the framework of several projects. Among these project, RESIF (Réseau sismologique et géodésique français) allows the instrumentation of broad-band seismic stations, separated by 50-100 km. With the recent and future development of geothermal industrial projects in the Alsace region, the ObsNEF is responsible for designing, building and operating a dense regional seismic network in order to detect and localize earthquakes with both a completeness magnitude of 1.5 and no clipping for M6.0. The realization of the project has to be done prior to the summer 2016

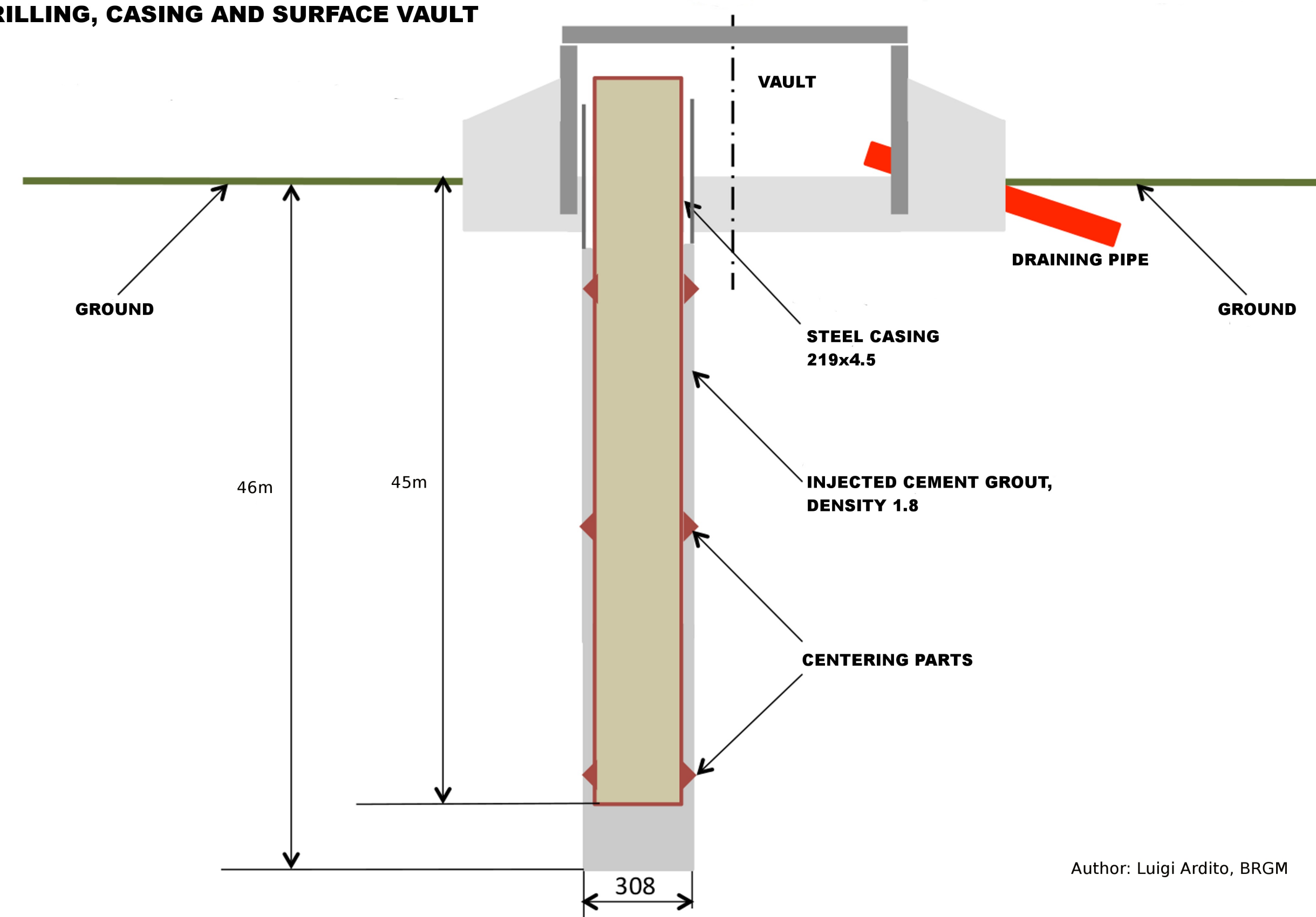
Several complex technical and financial constraints constitute such a projet. First, most of the Alsace Région (150x150 km<sup>2</sup>), particularly the whole Upper Rhine Graben, is a soft-soil plain where seismic signals are dominated by a high frequency noise level. Second, all the signals have to be transmitted in near real-time. And finally, the total cost of the project must not exceed \$450,000.

Regarding the noise level in Alsace, in order to make a reduction of 40 dB for frequencies above 1Hz, we program to instrument into 45m deep well with post-hole sensor for 6 stations out of 8 planned new stations. The 2 remaining would be located on bedrock along the Vosges piedmont. In order to be sensitive to low-magnitude regional events, we plan to install a low-noise short-period post-hole velocimeter. In order to avoid saturation for high potentiel local events (M6.0 at 10km), this velocimeter will be coupled with a surface strong-motion sensor. Regarding the connectivity, these stations will have no wired network, which reduces linking costs and delays. We will therefore use solar panels and a 3G/GPRS network. The infrastructure will be minimal and reduced to an outdoor box on a secured parcel of land. In addition to the data-logger, we will use a 12V ruggedized computer, hosting a seed-link server for near real-time transmission and a sync daemon for delayed-time transmission.

We plan to install and validate our first pilot station during the spring of 2016, and have an effective network by the summer of 2016.

## PLANNED INSTALLATION

### TECHNICAL CUT: DRILLING, CASING AND SURFACE VAULT



Scheme of the 45m deep posthole infrastructure, following the RESIF 5m deep posthole installation (Manhaval et al., 2015).

The depth of the sensor of this regional network has been chosen to be 45m in order to reduce high frequency noise of at least 30 dB (1-100Hz; Clinton et al., 2002; Withers et al., 1996). This depth may be redefined after the installation of a pilot site in the spring of 2016. Six of the eight stations will be powered with solar panels and the communications will be through GPRS/3G network.

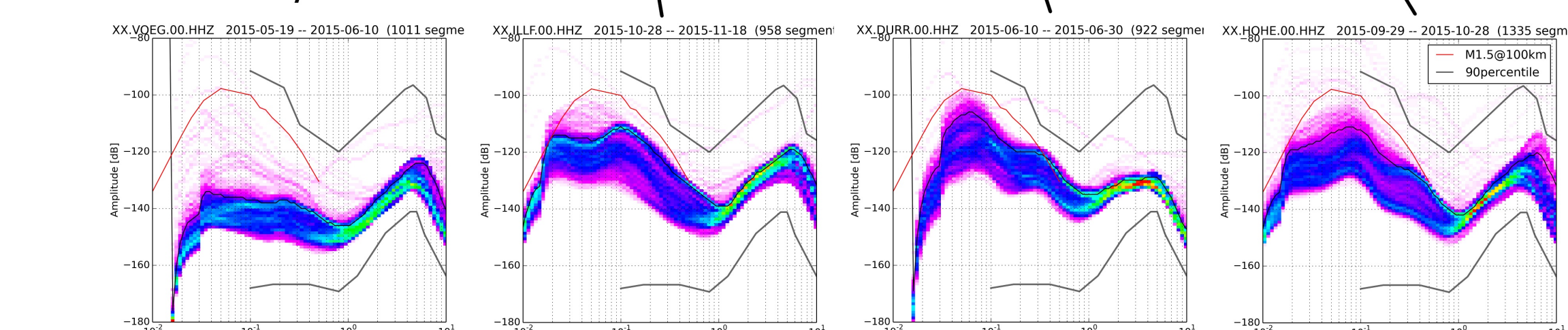
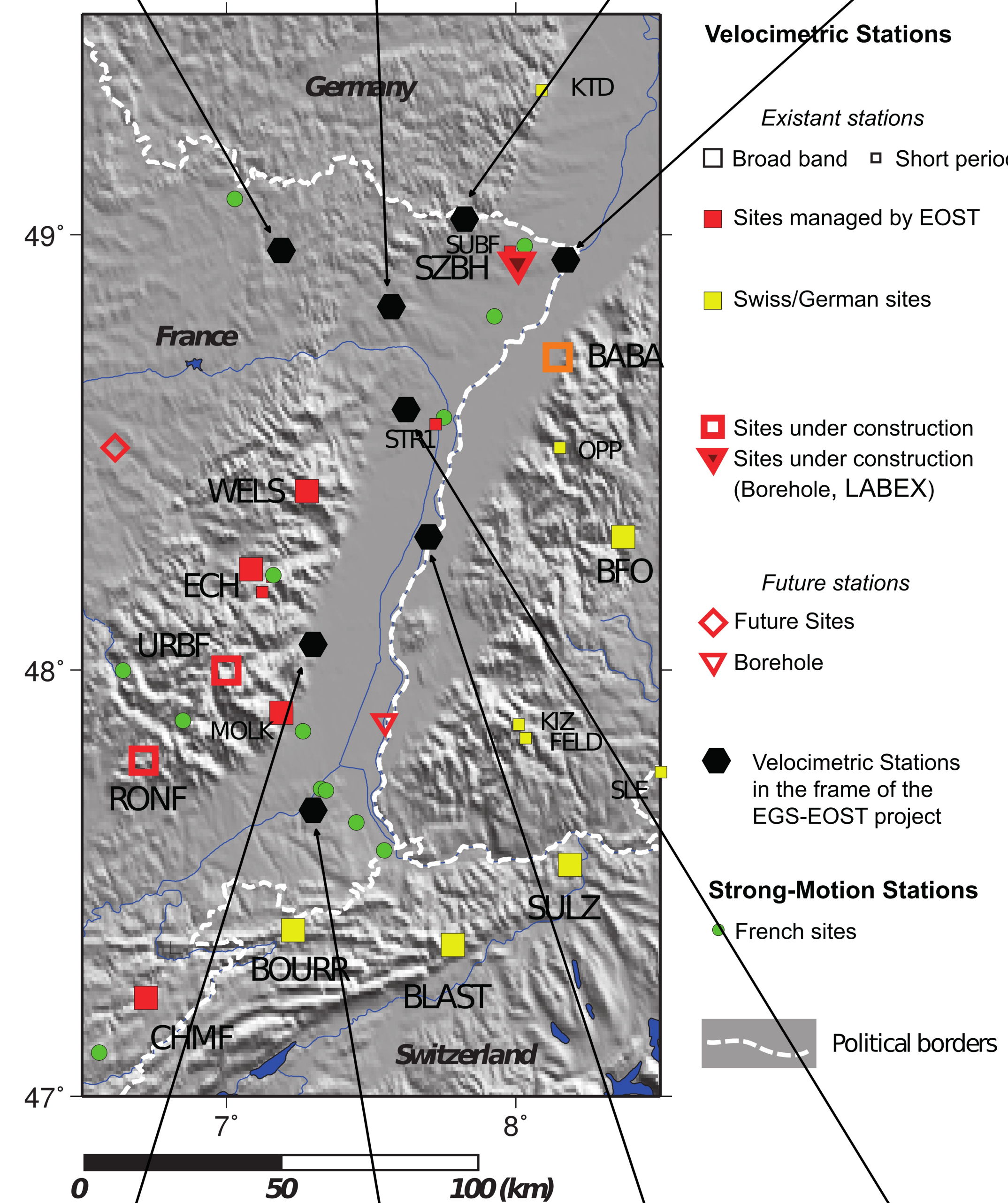
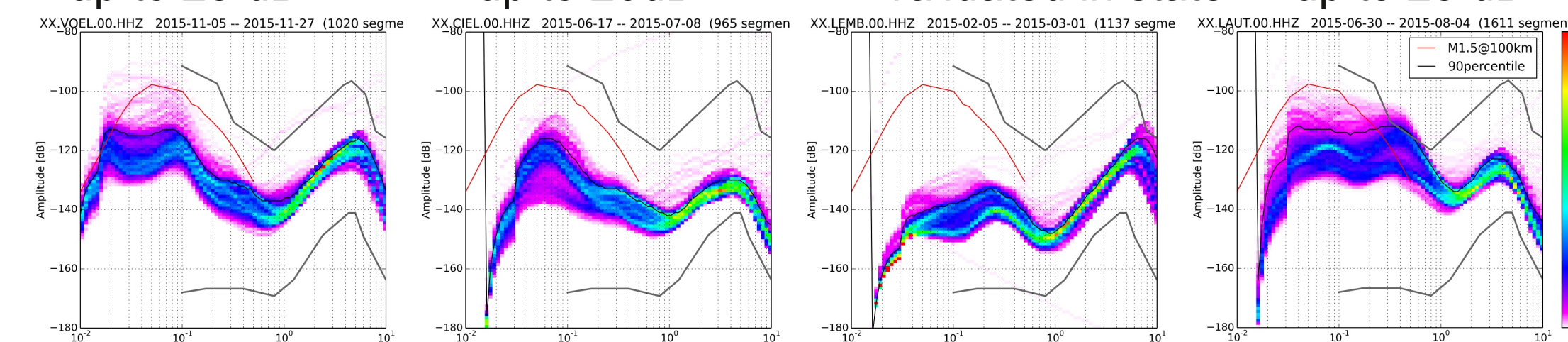
## PROSPECTION RESULTS

The region under study includes the large Plain of Alsace, characterized by several thousand meters of sediments (marls, gravels) with water. Most of the sites are selected to be on rock (sandstone), but these ideal conditions were not always realized. Also, the region corresponds to a densely populated urban area, with many human activities. Therefore a series of tests have been made to facilitate rigorous site selection.

The site locations are validated for permanent installation if the noise level is lower than 135 dB ( $f > 1\text{Hz}$ ) during the test. For the other sites, several tests have been conducted. The best sites are selected in terms of both the noise and detection levels, and posthole infrastructures are also considered.

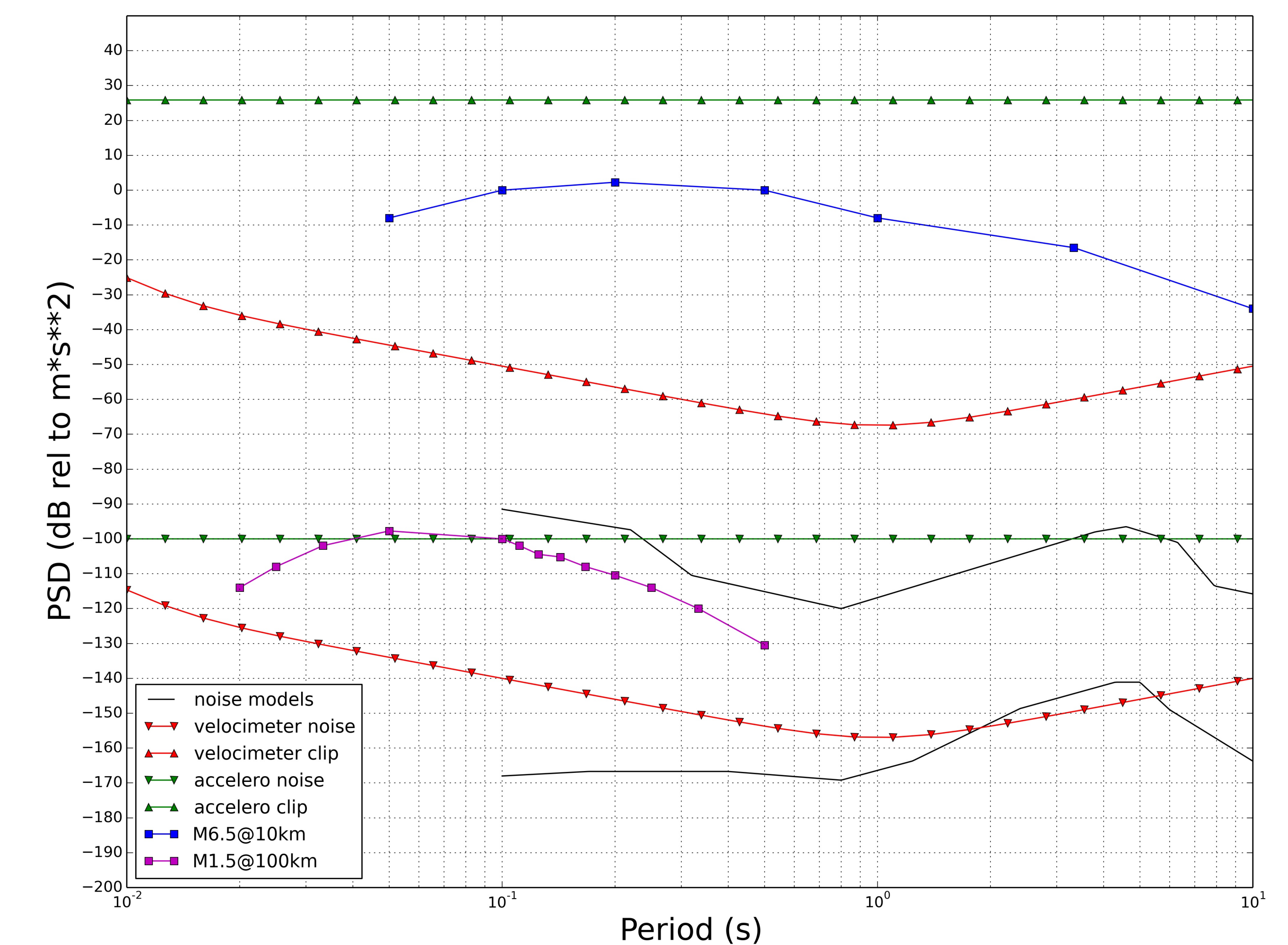
In order to reduce the costs, the sensor of two stations will be on surface vault.

Expected gain due to posthole installation in range 1-100Hz:  
VOELLERDINGEN: up to 25 dB  
VACANCIEL: up to 20dB  
LEMBACH: validated in state  
LAUTERBOURG: up to 25 dB



Expected gain due to posthole installation in range 1-100Hz:  
VOEGTLINSHOFFEN: validated in state  
ILLFURTH: up to 25dB  
DURRENENTZEN: up to 30 dB  
HOHENGOEFT: up to 25 dB

## INSTRUMENTATION ENGINEERING DESIGN



Technical characteristics of velocimetric sensor have been specified in order to measure a low noise for a M1.5 earthquake located 100 km away (Clinton et al. 2002). Therefore, in the case of such an event in Alsace, at least 4 stations would detect it.

In addition, in order to avoid saturation for large events (M6.5) which could potentially occur in the region, all stations will be complemented by a strong motion sensor. In the case of a posthole velocimeter, the strong motion sensor will be installed within the vault at surface.

## PERSPECTIVES

The first posthole installation will be crucial to estimate the high frequency noise reduction, and allow us to adapt the depth requirement for the subsequent stations.

The instruments are currently in the way to be delivered to the lab, where we will perform calibration tests and noise measurements to insure the acquisition chain regarding the instrumentation tender specifications.

The whole network is scheduled to be operating in summer 2016.

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