



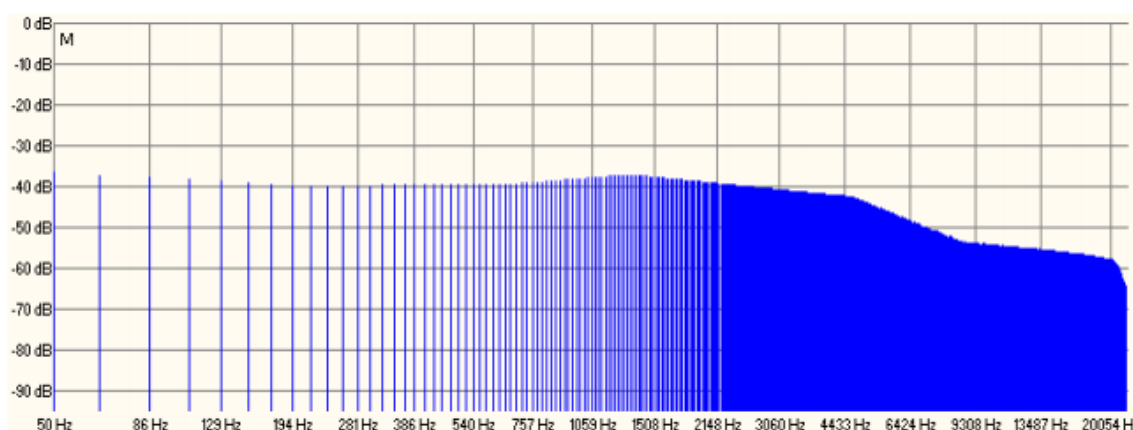
## IMPORTANT

Sound measured in decibels is not relevant under water. Decibels are valid only when the sound waves are airborne. That is why we have not measured them in decibels. Technically speaking, a decibel is a unit that measures the pressure difference between two states, and traditional experience at 1W under 1m gives a value in "SPL" (sound pressure level) dB in reference to the value of 0 dB SPL (20 micropascals) which is the hearing threshold at 1 kHz airborne. Under water, the hearing threshold is 1 micropascal at 1kHz and corresponds to the reference 0 dB "SL" (sound level). To my knowledge, this reference is never used. Therefore, we can say that underwater perception thresholds are 30 to 50 dB above airborne thresholds measured. Although some manufacturers show sound pressure values in dB "SPL", it should be noted that this value cannot be implemented in dB "SL".

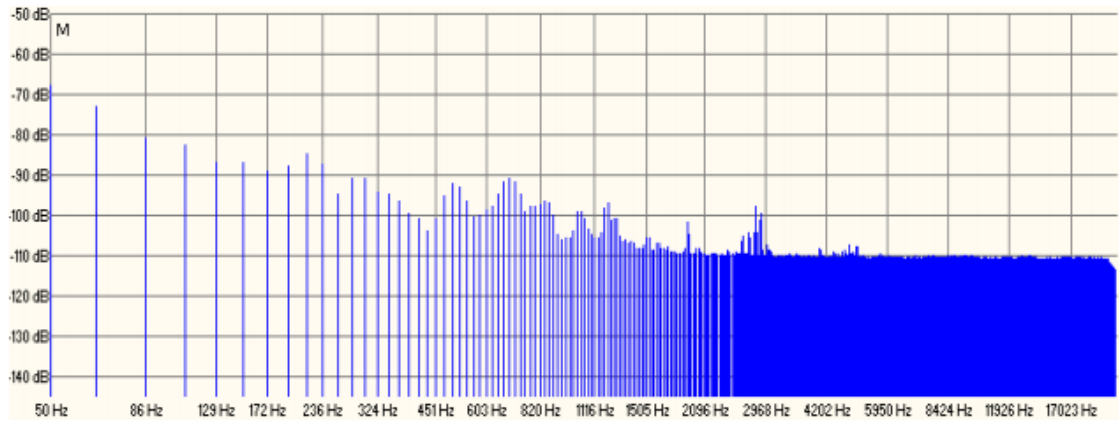
### 7.1.2.2 Experimental conditions

On 29<sup>th</sup> September 2008, three speakers of the H062m type were measured in the IFREMER laboratory test tank in La Seyne-sur-Mer, near Toulon. The speakers were later labelled HP1, HP2 and HP3.

The test tank is a pit measuring 10 x 15 metres with a depth of 6 metres. A Faze brand amplifier was used (the frequency response was measured at output to assess the contribution of the amplifier in the audio chain). For all measurements, the amplifier settings were identical. A hydrophone, model B&K 8103, was used for these evaluations. The excitation signal was a sweep of 30 seconds generated by Altiverb, as for all the measurements in the Mathis pool.



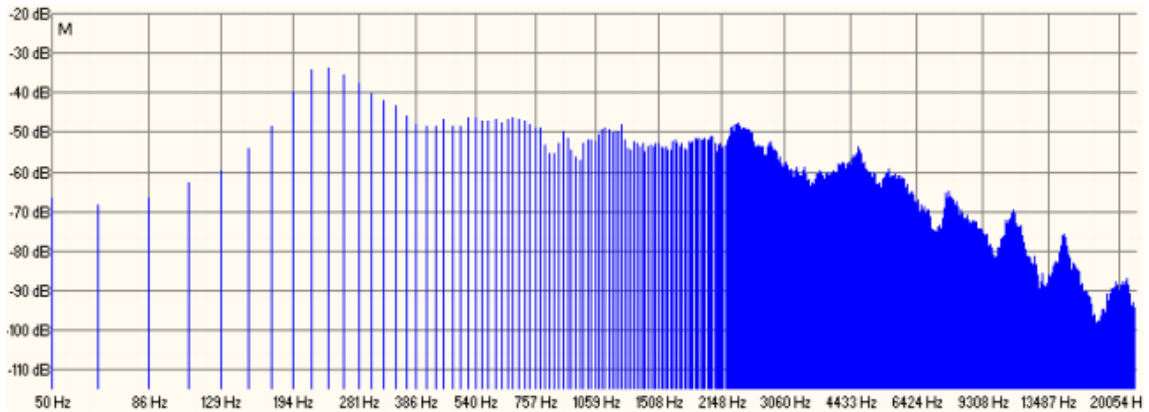
FFT sweep after amplification



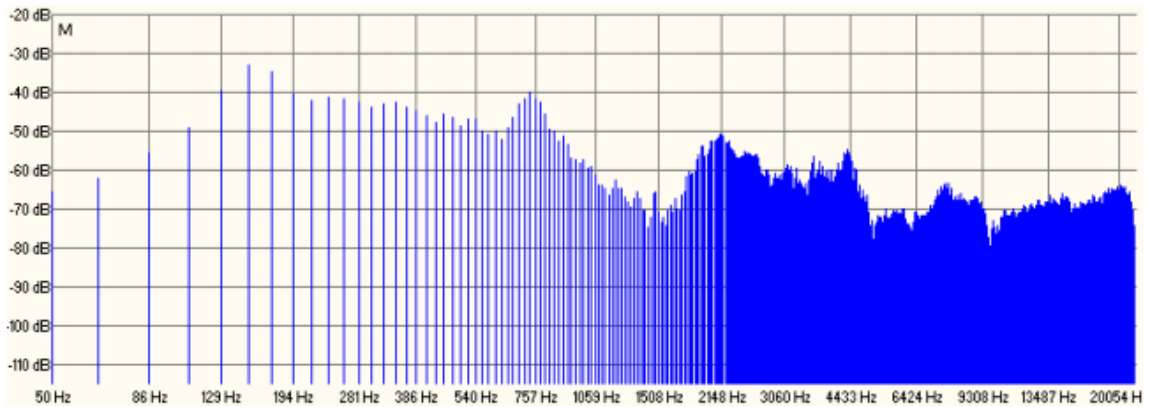
**FFT of background noise in the test tank**

### 7.1.2.3 Frequency responses

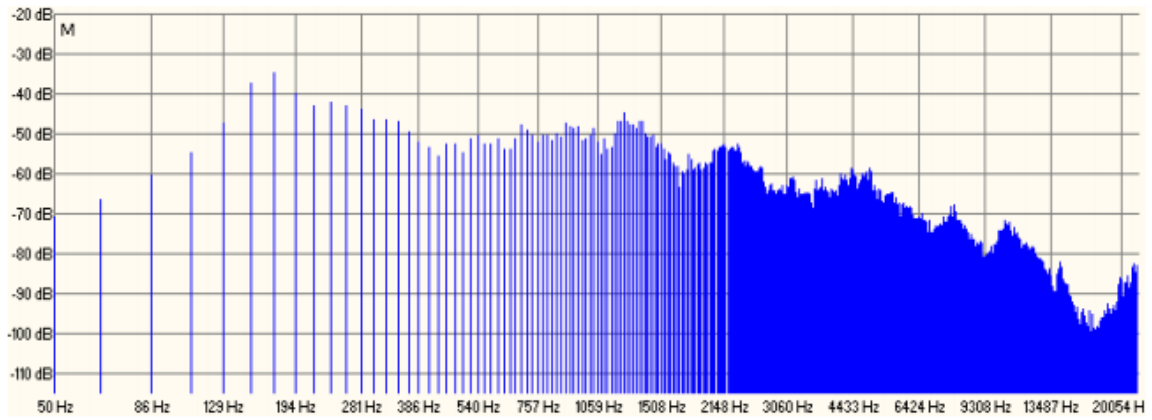
Measurements were taken one metre from the speaker, at a depth of 2.50 m.



**HP1 at 1 metre in the axis**



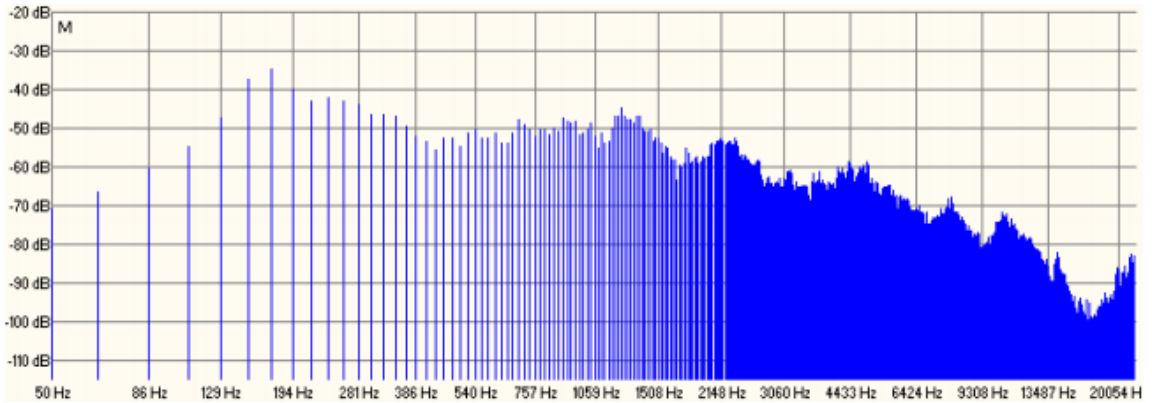
**HP2 at 1 metre in the axis**



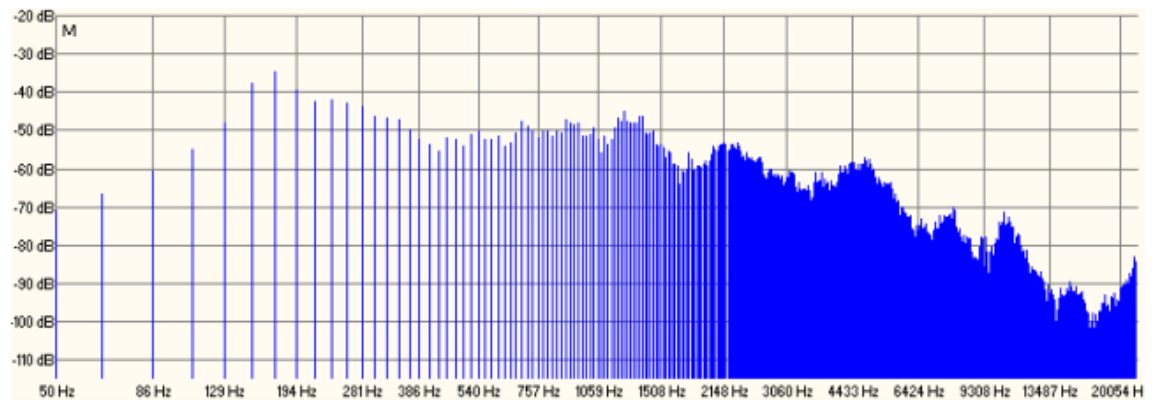
**HP3 at 1 metre in the axis**

### 7.1.2.4 Directivity

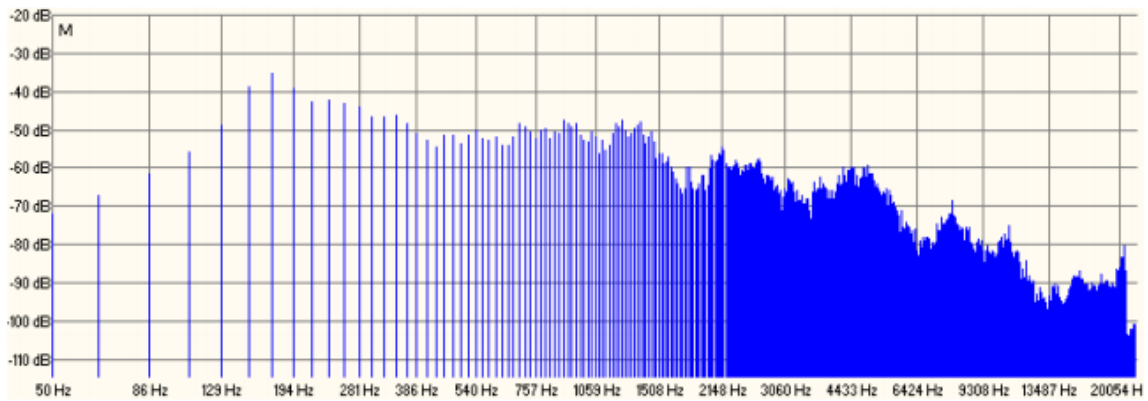
The HP3 is shown here. The measurements were taken at 0°, 45° and 90° at a distance of 1 metre.



**HP3 at 1 metre in the axis**



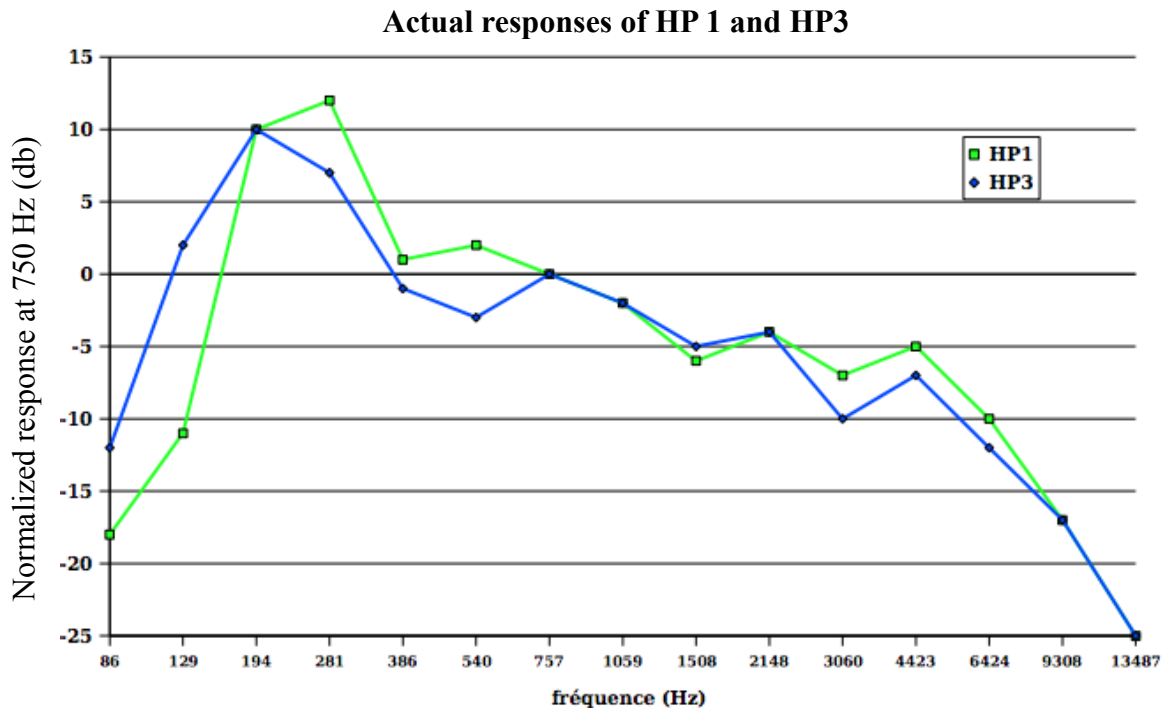
**HP3 at 1 metre at 45°**



HP3 at 1 metre at 90°

### 7.1.2.5 Argument

The first three axial modes of the tank are at frequencies of 50 Hz, 75 Hz and 135 Hz; they do not appear on the response curves. The 50Hz and 75Hz frequencies are below the bandwidth of the speakers, and the frequency of 135 Hz (corresponding to a water depth of 5.50 m) does not appear. In addition, the tank is located near the sea and is built in waterlogged soil, meaning that the sound waves travel through the ground quite well. It is therefore well anchored and has less significant vibratory activity than the Mathis pool. The tank can be considered as relatively neutral, with a low "acoustic fingerprint" (see [hyp](#) No. 2, page 59) and the measured response curves are largely attributable to the speakers. The measurements are quite different from one speaker to another, especially the HP2. The HP1 and HP3 are more alike, and their actual response curves (after offset against the output of the amplifier) are shown below:



From 350Hz to 5kHz, the indicators remain in the range of 10 dB, on the contrary, the two speakers show a presence peak in the lower midrange (between 100 Hz and 300 Hz) and have a pronounced loss in the trebles (-12 dB by octave from 5 kHz) with peaks (+10 dB) at 8k, 11k and 15kHz.

Finally, we note that the speakers are poorly directional in the horizontal plane: the curves in the axis,  $45^\circ$  and  $90^\circ$  are almost identical.