

Acoustic detection activity in Genoa

ARENA 2008

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25 giugno 2008

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- 1 it is completely passive (being read out from the shore without amplifiers or ADC convertes).
- 2 I have investigate the possibility to increase the bandwidth range up to 20 KHz: this bandwidth is more large than in the conventional hydrophones developed since 80s.

An hydrophone is made up of:

- 1 an external active cylinder (Mandrel) made of **ULTEM 1000** on wich several fiber layer are wrapped (**6 layer, 698 spires and $\approx 37 m$ of fiber for the prototype**)
- 2 an internal passive cylinder (made of Alluminium) working as rigid support with two O-ring
- 3 an air gap between the two cylinders allowing the mandrel to vibrate.

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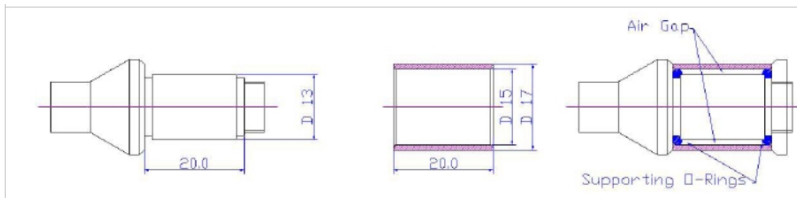


Fig.1: the lay out of the hydrophone

| Parameter | Active cylinder | Passive cylinder |
|----------------|-----------------|------------------|
| outer diameter | 17 mm | 13 mm |
| inner diameter | 15 mm | // |
| length | 20 mm | 20 mm |

Tabella: Geometrical dimensions of the cylinders.

In this design an active cylinder is mounted outside a passive hollow inner tube with sufficient clearance to provide air-backing.

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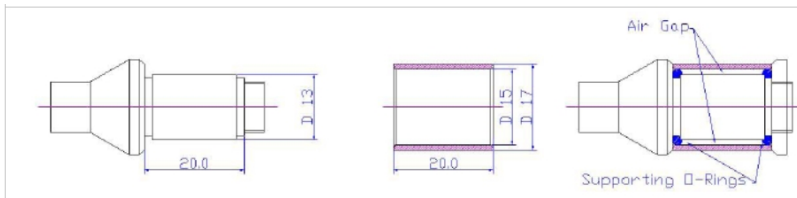


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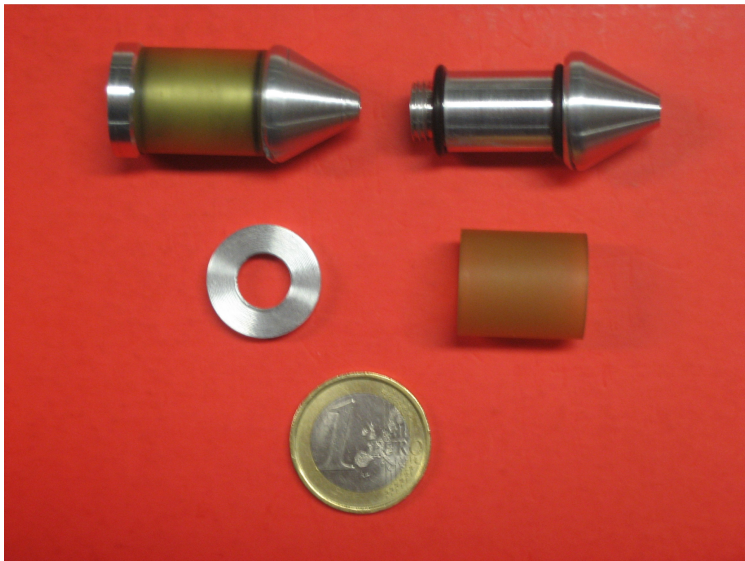


Figura: The prototype.

How the Hydrophone works: operation principle

- 1 According to the thermo-acoustic model an high energy shower produced by ultra high energy neutrinos interactions in water is detected via acoustic pressure pulse
- 2 the pulse pressure induces a mandrel oscillations
- 3 the fiber wrapped on the mandrel change its length ΔL and when the laser light passes through it this produces an optical path variation
- 4 a simple interference measure obtained placing two mirrors at the ends of the hydrophone allows to estimate the pressure pulse value.

The hydrophone acts as a interferometer therefore the device is completely passive. The possibility to increase the bandwidth is directly connected to the hydrophones dimensions: more small they are more greater is the bandwidth. For the values selected the bandwidth is about 20 KHz .

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The construction of the fiber layers

I have used some special fibre **CL1310 – 16D** for the layers fabrications. The fiber solenoid construction procedure is very complex.

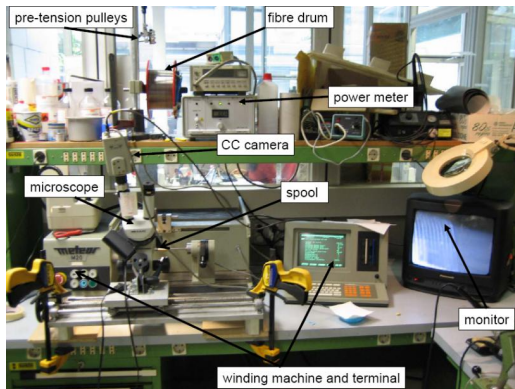


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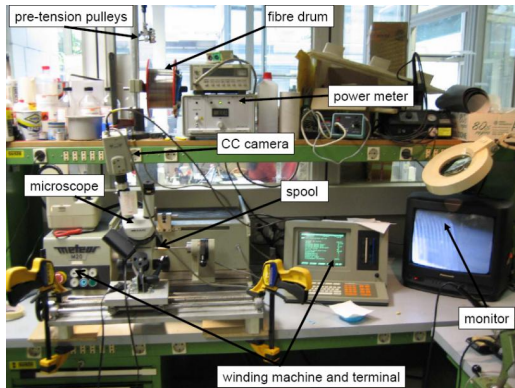


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The light attenuation does not increase with the number of layers and the average value is (-1.3 ± 0.3) dB.

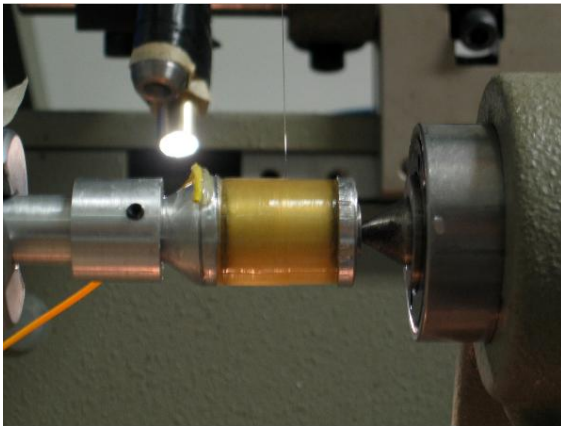


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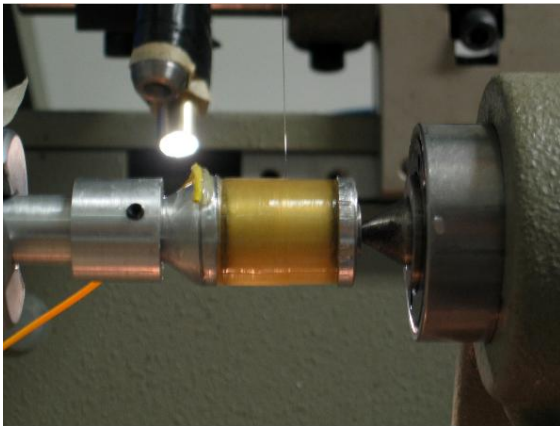


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Hydrophone measurements in air

The aim of the measurements is to study the hydrophone characteristic frequency response.

Hydrophone calibrations are performed with the help of a microphone **Bruel&Kjaer Condenser Microphone Type 4133** with a known characteristic frequency response.

Optical read-out system calibration

The read-out system is calibrated for different frequencies and corresponding hydrophone response in $dB V$ is determined

Devices calibration

From the comparison between microphone and hydrophone it is possible to calculate the hydrophone absolute frequency response in $dB re rad/\mu Pa$ and also, knowing the absolute signal value in Pa , the minimum pressure detectable.

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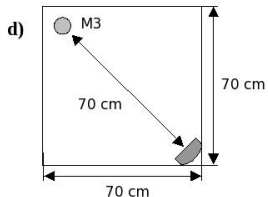
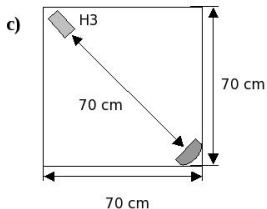
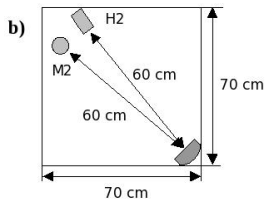
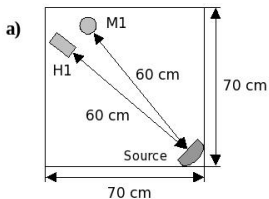
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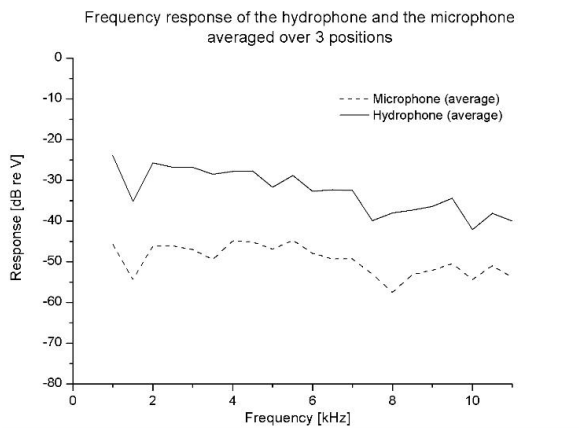
Experimental set-up

The hydrophone and the microphone are placed in a cubic chamber with a $70 \times 70 \times 70 \text{ cm}^3$ volume. Measurements are performed for 4 different arrangements of sound detector inside the chamber.



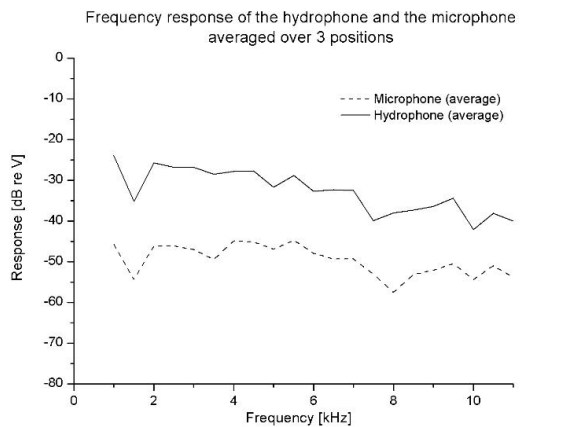
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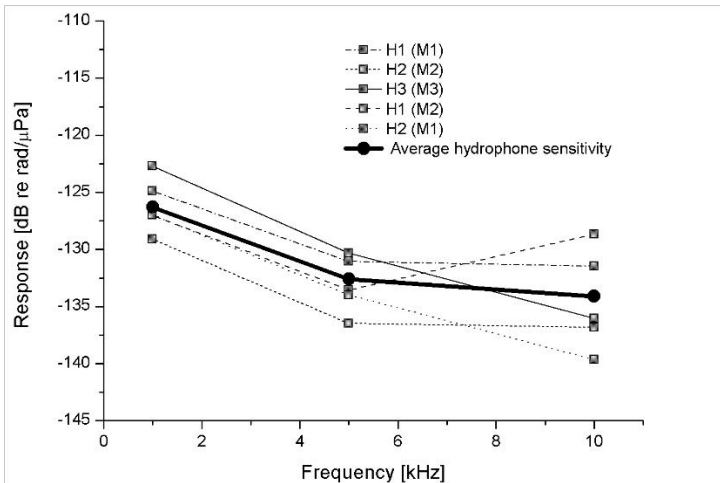
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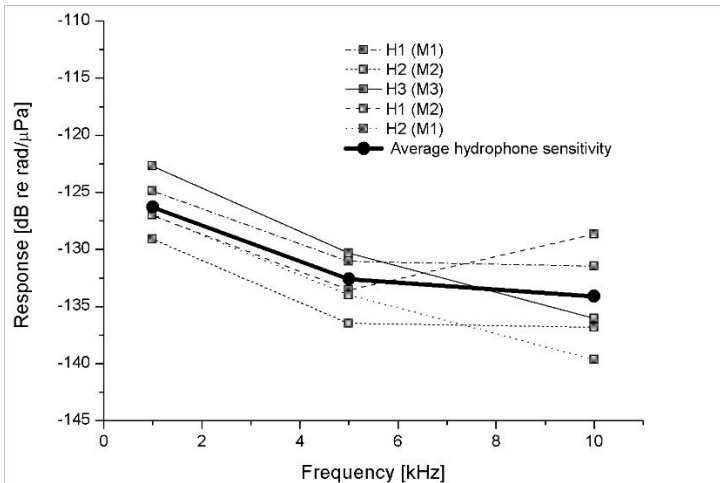
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Hydrophone sensitivity in $dB re rad/\mu Pa$ at different positions calculated using the calibration



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Remarks

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The only way is to find a pressure value corresponding to the minimum signal which I can extract from the noise.

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- ② reading electronics **work in progress**
- ③ tests in water **to make**

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