NEutrino
Mediterranean
Observatory

G. Riccobene, for the NEMO Collaboration
Presented by A. Capone

Urick

Expected neutrino signal (a.u.)
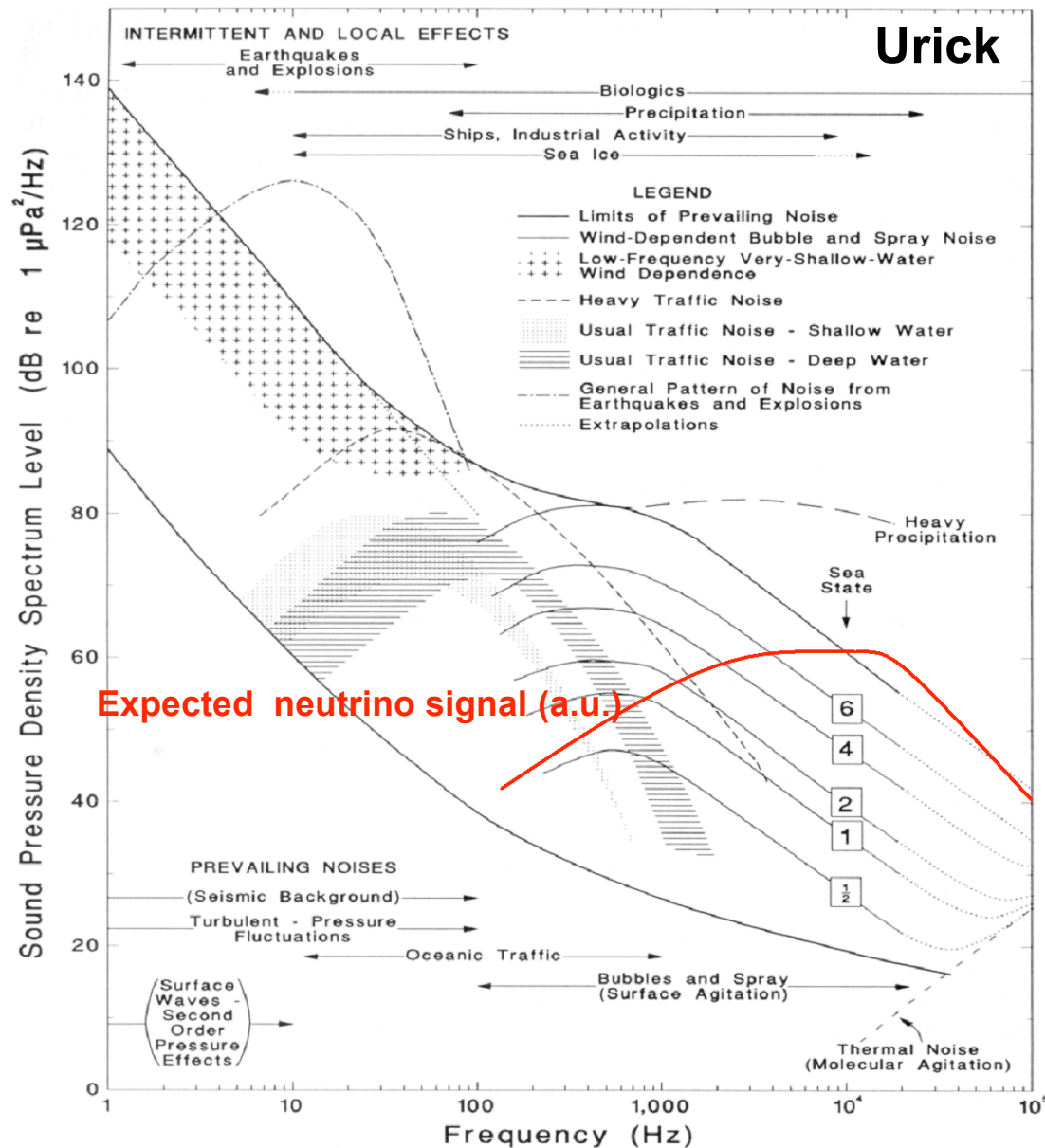
The NEMO Collaboration started preliminary studies on the acoustic detection technique, firstly suggested by Askarian in '50s.

Knowledge of the ocean noise at large depth is needed to develop acoustic detection systems.
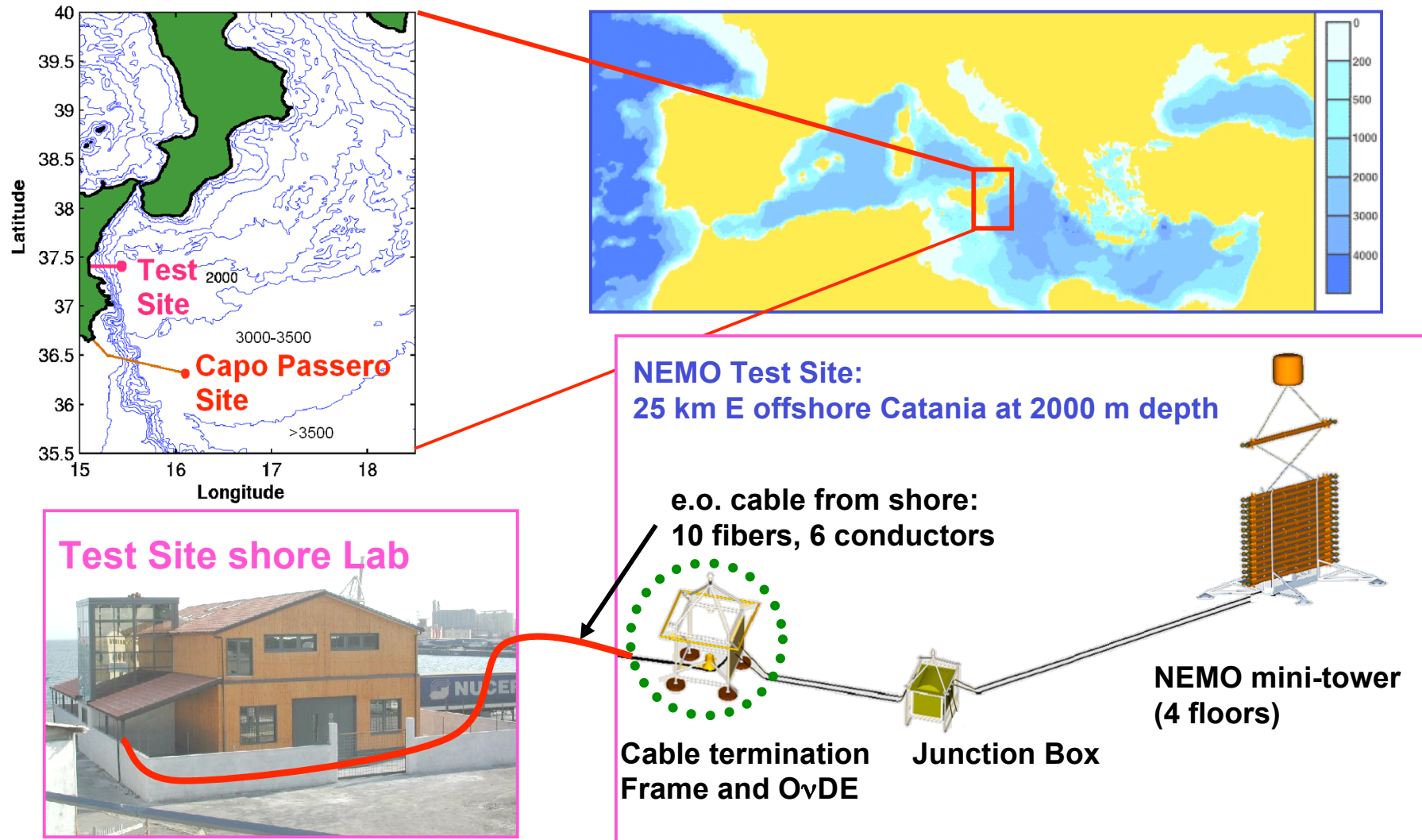(and it is extremely interesting for multidiscininary sciences !)

There is a lack of long term measurements at large depth.

NEMO deployed a Deep-Sea station for acoustic noise monitoring using the Test Site infrastructures.

23 January 2005

ROV

OνDE connection

The NEMO Collaboration is performing the **Phase 1** of the project, installing a fully equipped **deep-sea facility to test prototypes and develop new technologies for the km³ detector.**

NEMO Test Site:
25 km E offshore Catania at 2000 m depth

Test Site shore Lab

e.o. cable from shore:
10 fibers, 6 conductors

NEMO mini-tower
(4 floors)

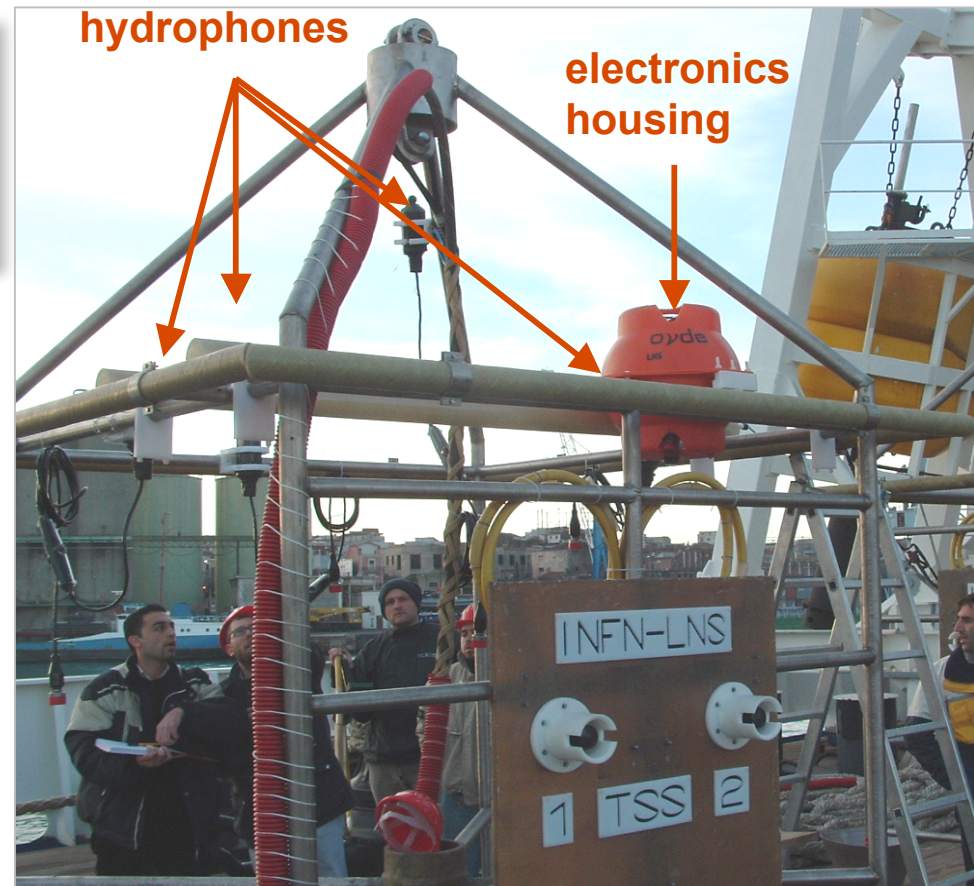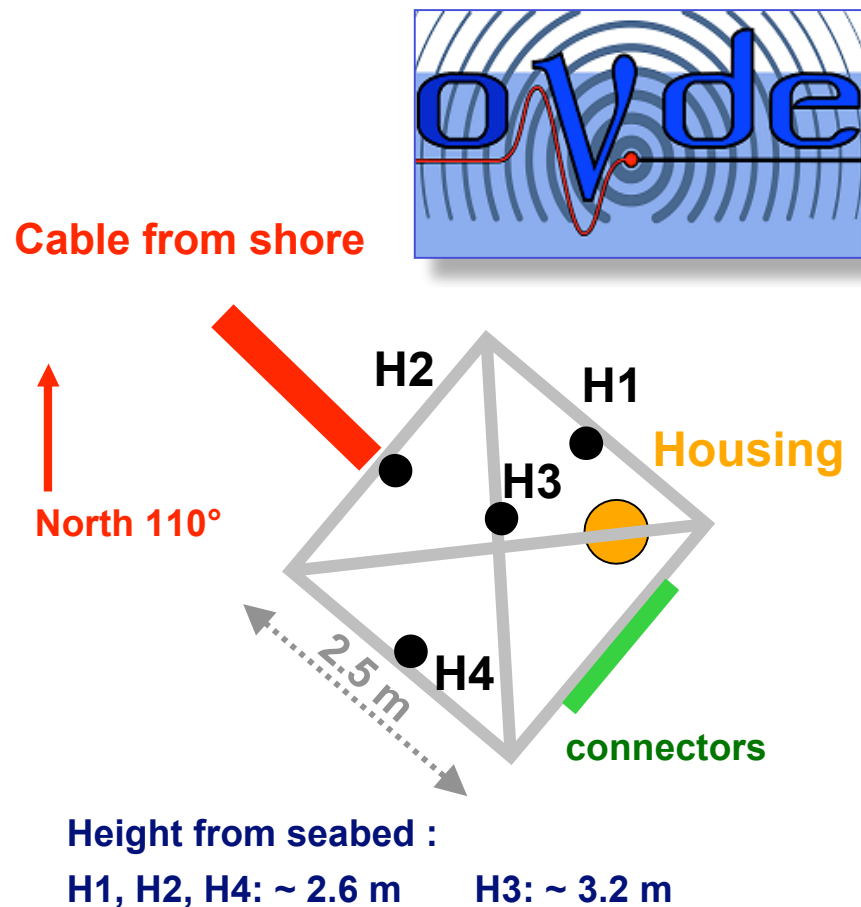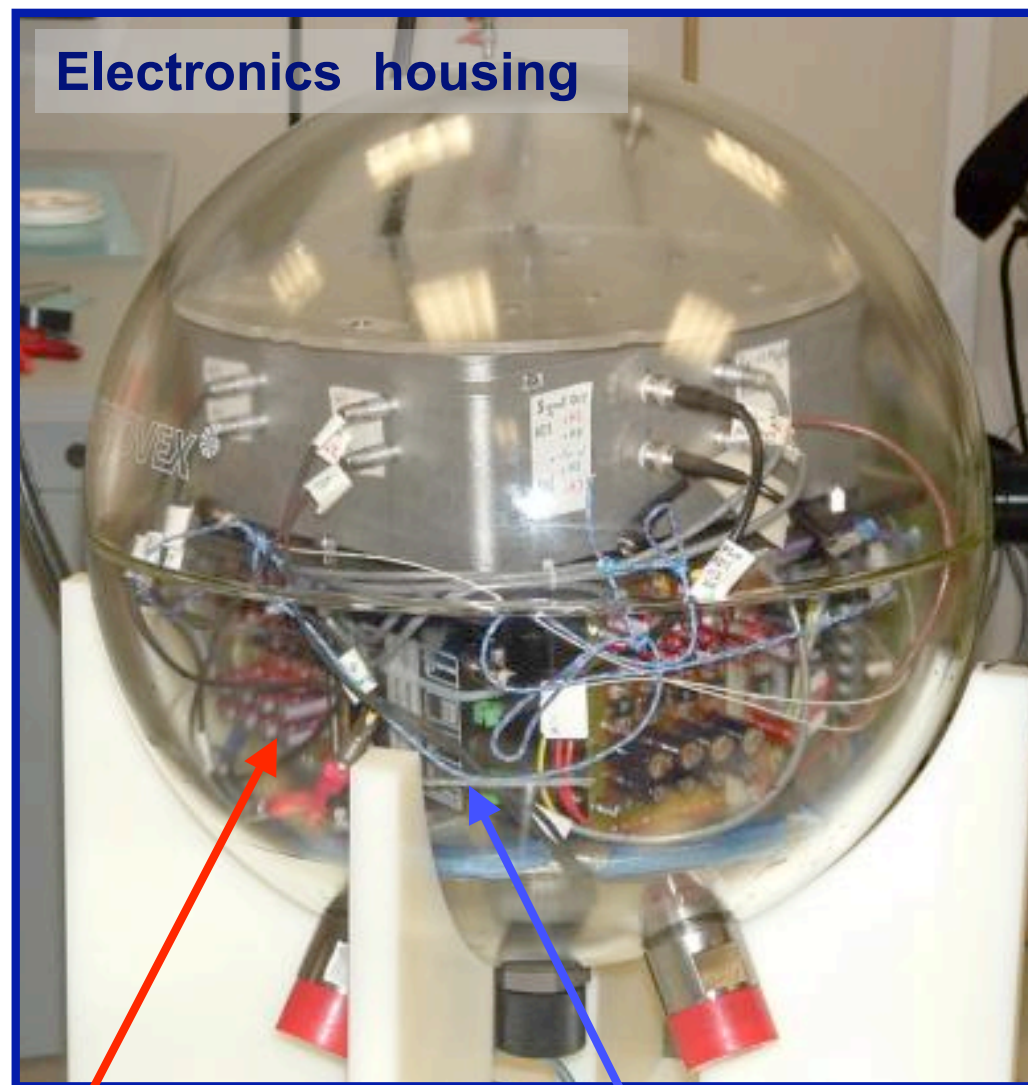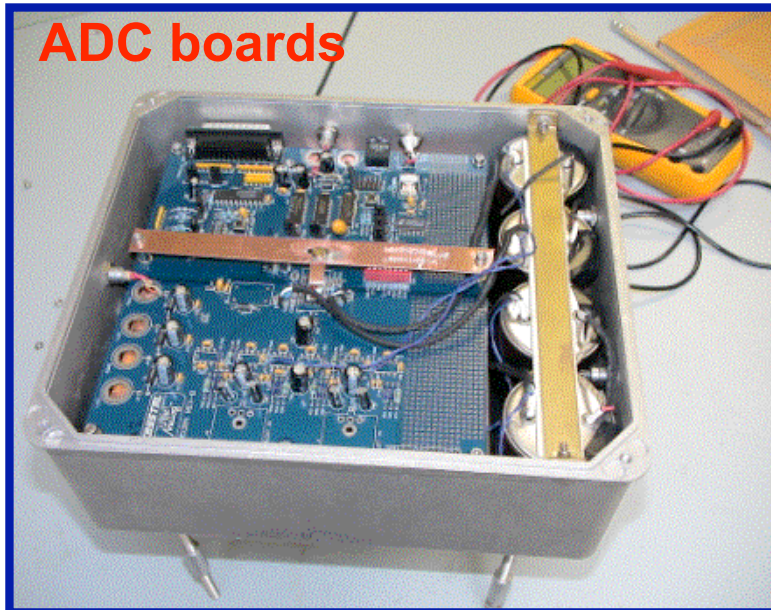**Cable termination**
Frame and OνDE

Junction Box

Installed on NEMO TSS (Test Site South) frame.

Equipped with 4 hydrophones, acoustic signal digitization (24bit@96 kHz) at 2000m depth.

On-line monitoring and data recording on shore.

Continuous data taking since Jan 23, 2005.

Cable from shore

North 110°
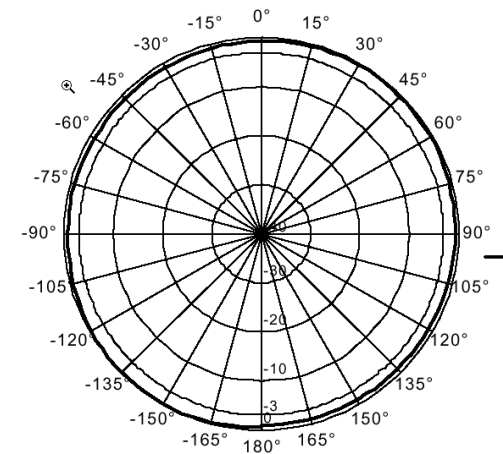
H2 H1

H3

Housing

2.5 m

H4

connectors

Height from seabed :

H1, H2, H4: ~ 2.6 m   H3: ~ 3.2 m

hydrophones

electronics housing

Hydrophone housing

RESON
Hydrophone
4042-C

RESON
preamp board

ADC boards

Electronics housing

Power:
transformers and
regulators

Electro/Optical
Modem

Special production for NEMO operating depth 2500 m
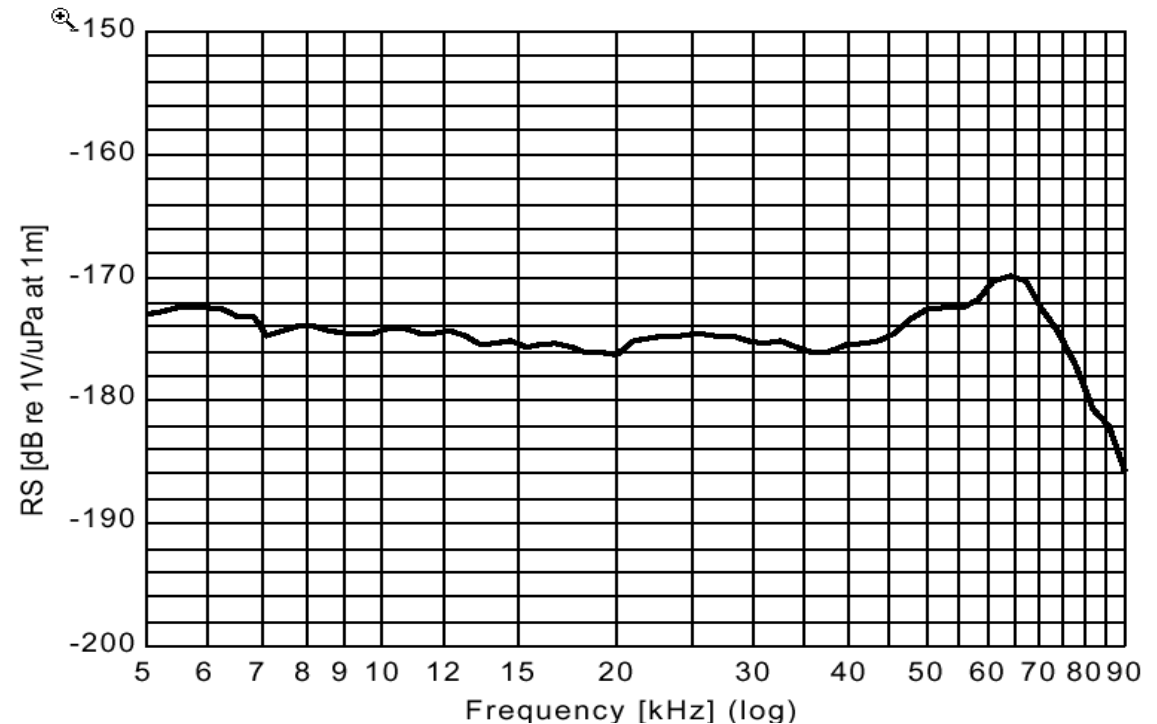
Usable Frequency range:	1 Hz - 80 kHz
Linear Frequency range:	1 Hz to 50 kHz
Receiving sensitivity nominal:	-194dB ±3 re 1V/uPa (+20dB preamplifier)
Horizontal Directivity Pattern:	Omnidirectional ±2dB at 40 kHz
Vertical Directivity Pattern:	270° ±3 dB at 40 kHz
Operating depth:	1500 m
Survival depth:	2000 m
Metal body:	Aluminum (Seabronze for NEMO)

96 kHz 24 bits

H1-H3
broad band
(30 Hz- 50 kHz)

preamp

ADC 2

ADC 1

SPDIF
protocol

H2-H4
filtered
(1 kHz- 50 kHz)

SPDIF

E/O Modem
transmitters

DAQ on shore

E/O Modem
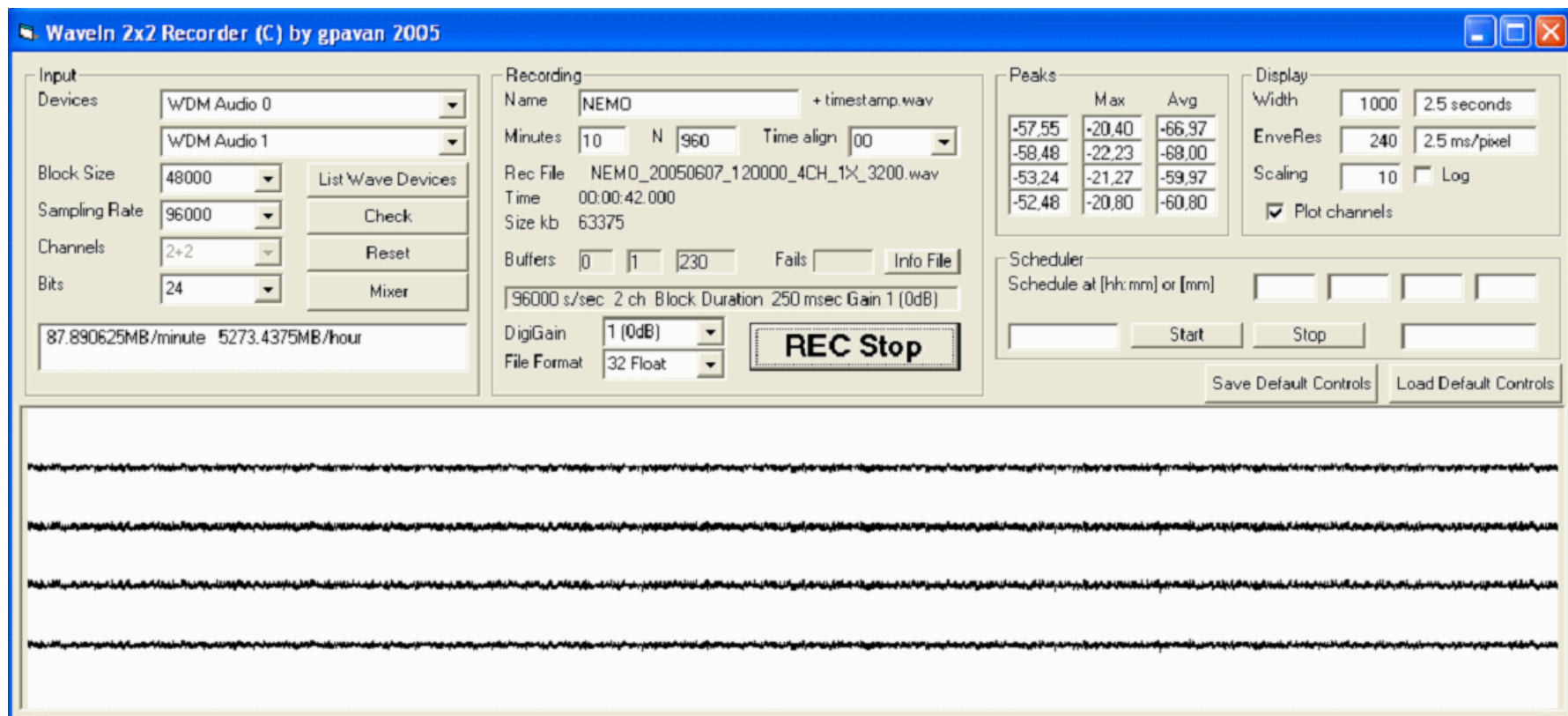receiver

25 km optical fibre
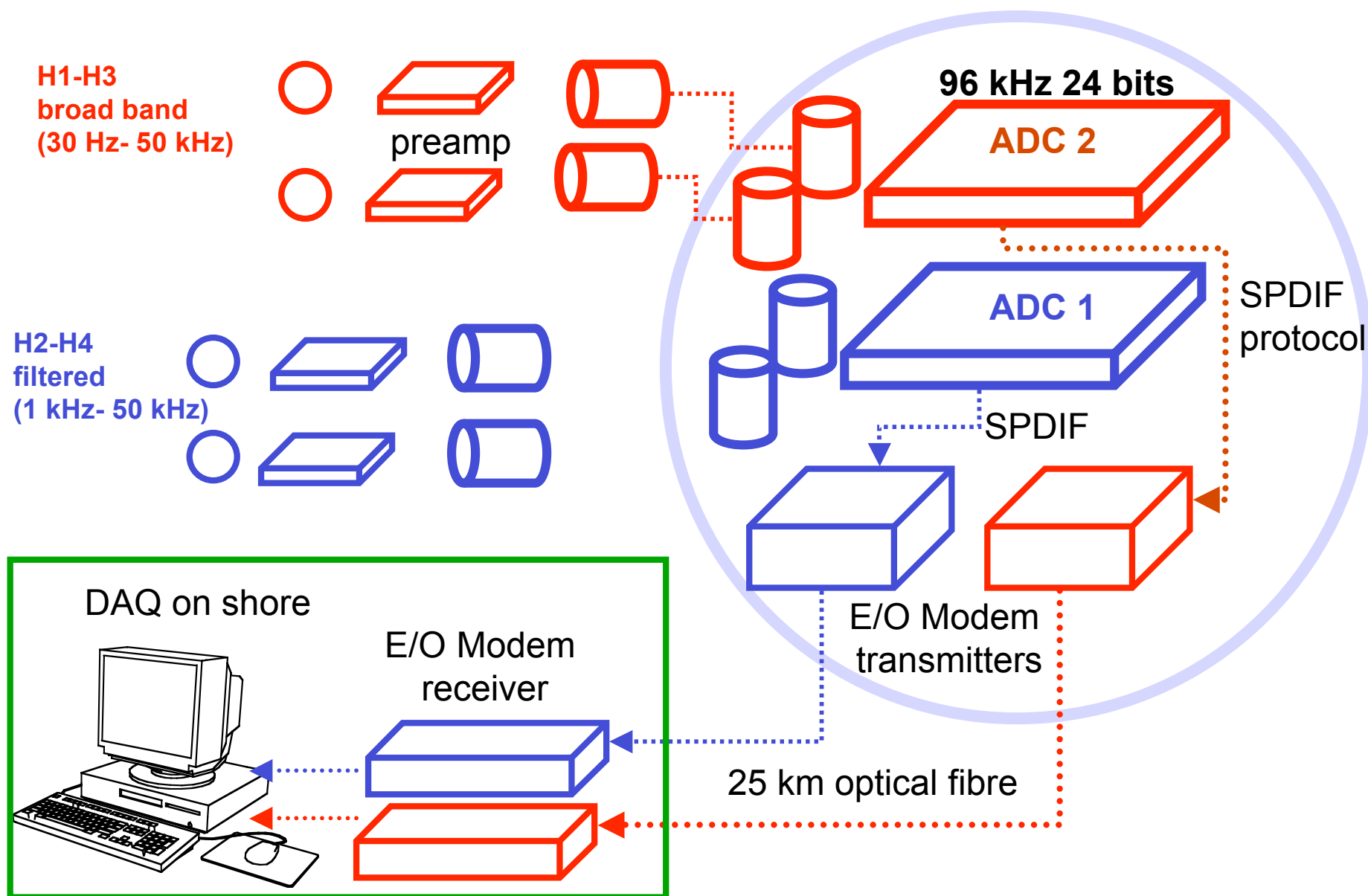
From Jan 23 to Jan 28 (2005): continuous (2 hydrophones per time – 1 stereo PCM file)

From Jan 29 to Apr 8:   5' per hour (2 hydrophones per time – 1 stereo PCM file)

From April 9 to Jun 28: 5' per hour (4 hydrophones synchronized – 2 stereo PCM files)

From Jun 29 (2005) on: 5' per hour (4 hydrophones synchronized – 4 Channel PCM file)

**DAQ software: 4 Channel *Wave-in Recorder* by CIBRA (G.Pavan)**

Estimated sensitivity of channel H1 :-175 dB re 1V/μPa　　　**Hydro: -195 dB**　　　**Preamp: + 20 dB**
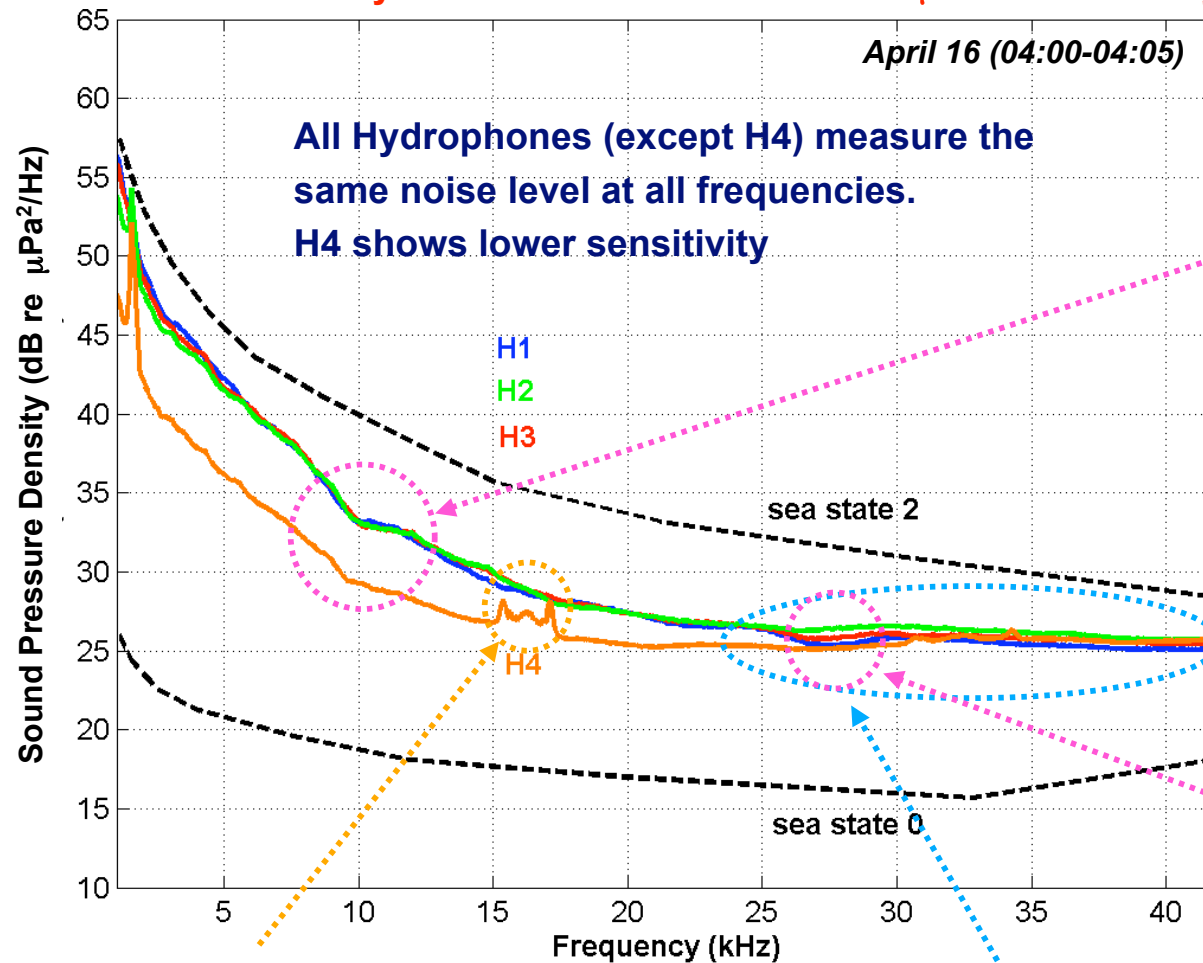
April 16 (04:00-04:05)

All Hydrophones (except H4) measure the same noise level at all frequencies.
H4 shows lower sensitivity

H1
H2
H3

sea state 2

sea state 0

H4

Gap at 10 kHz is probably to be ascribed to wave reflection on the metallic vessel. The gap was not observed in air.

1.5 cm
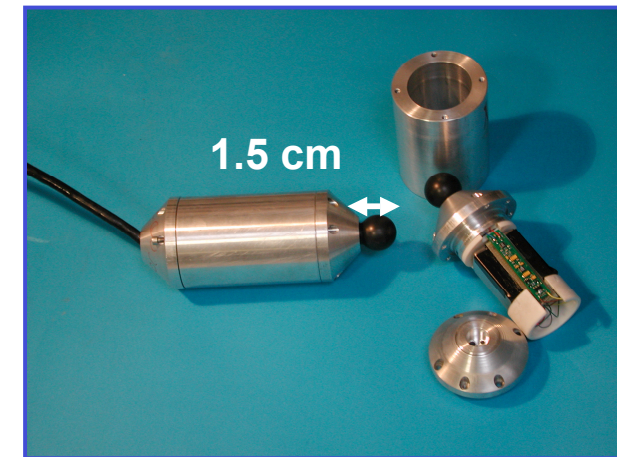
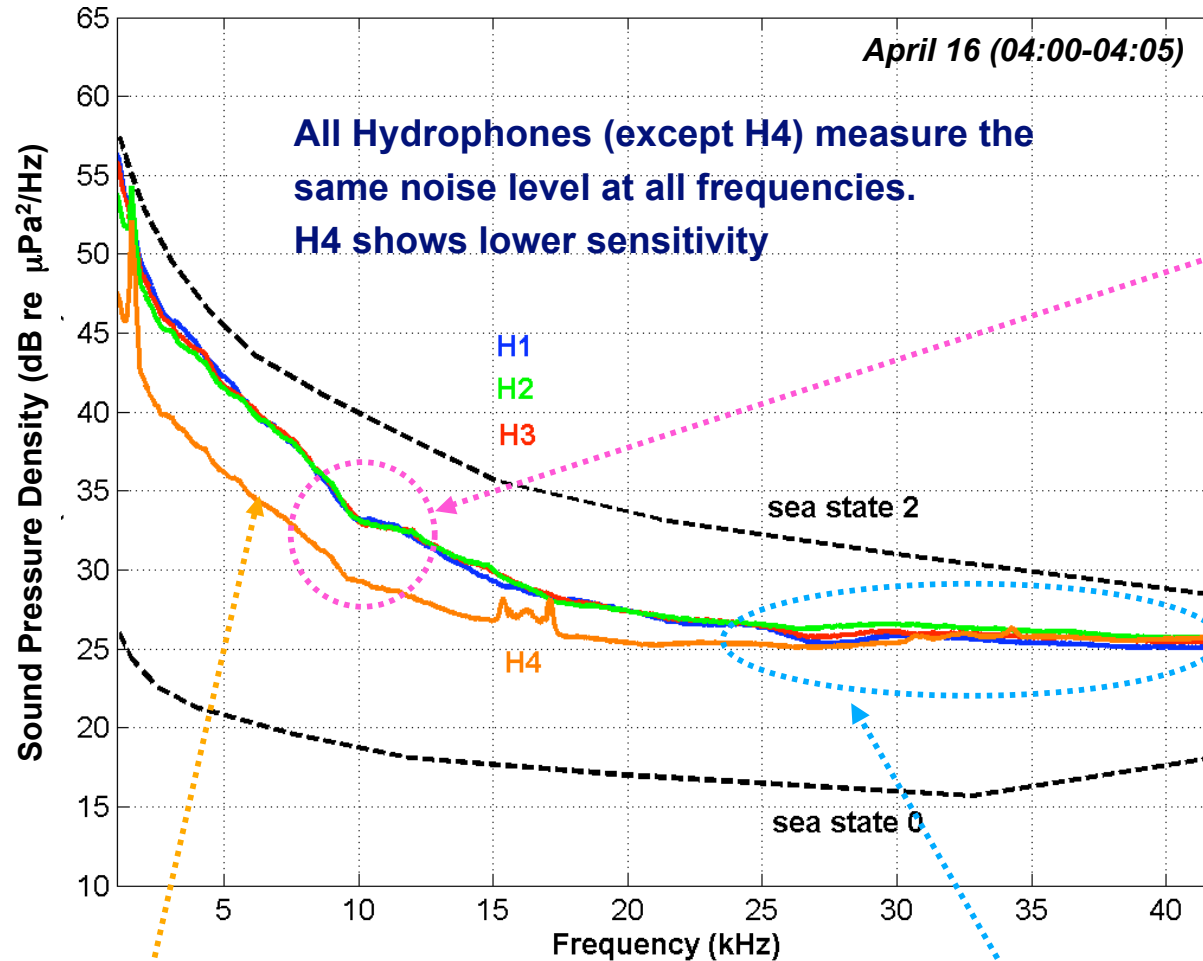Gap at 28 kHz is not yet explained

H4 could not be calibrated before deployment.
Resonances at 15-17 kHz could be ascribed to the filtering stage.

Electronics + hydrophone noise plateau

Estimated sensitivity of channel H1 :-175 dB re 1V/μPa   **Hydro: -195 dB**   **Preamp: + 20 dB**

April 16 (04:00-04:05)

All Hydrophones (except H4) measure the same noise level at all frequencies. H4 shows lower sensitivity

H1
H2
H3

sea state 2

H4

sea state 0

Gap at 10 kHz is probably to be ascribed to wave reflection on the metallic vessel. The gap was not observed in air.

1.5 cm

H4 could not be calibrated before deployment.

Electronics + hydrophone noise plateau

- 4200 files analysed (1 file→ 5' recording);
- recording time was "almost" randomly chosen between the 0th and the 45th minute of each hour;
- about 3000 files under analysis;
- file analysis:

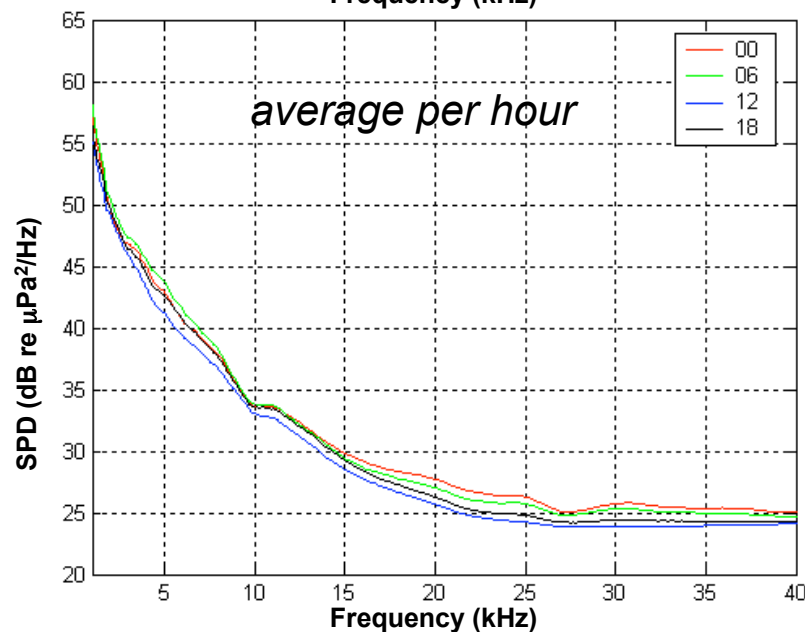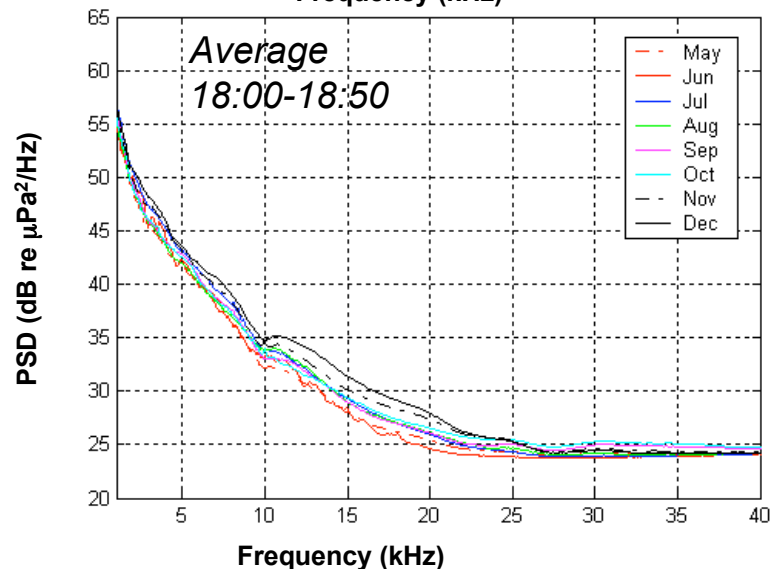 *periodogram of the data sample (2048 points FFT, 50% overlap, Hanning window).*
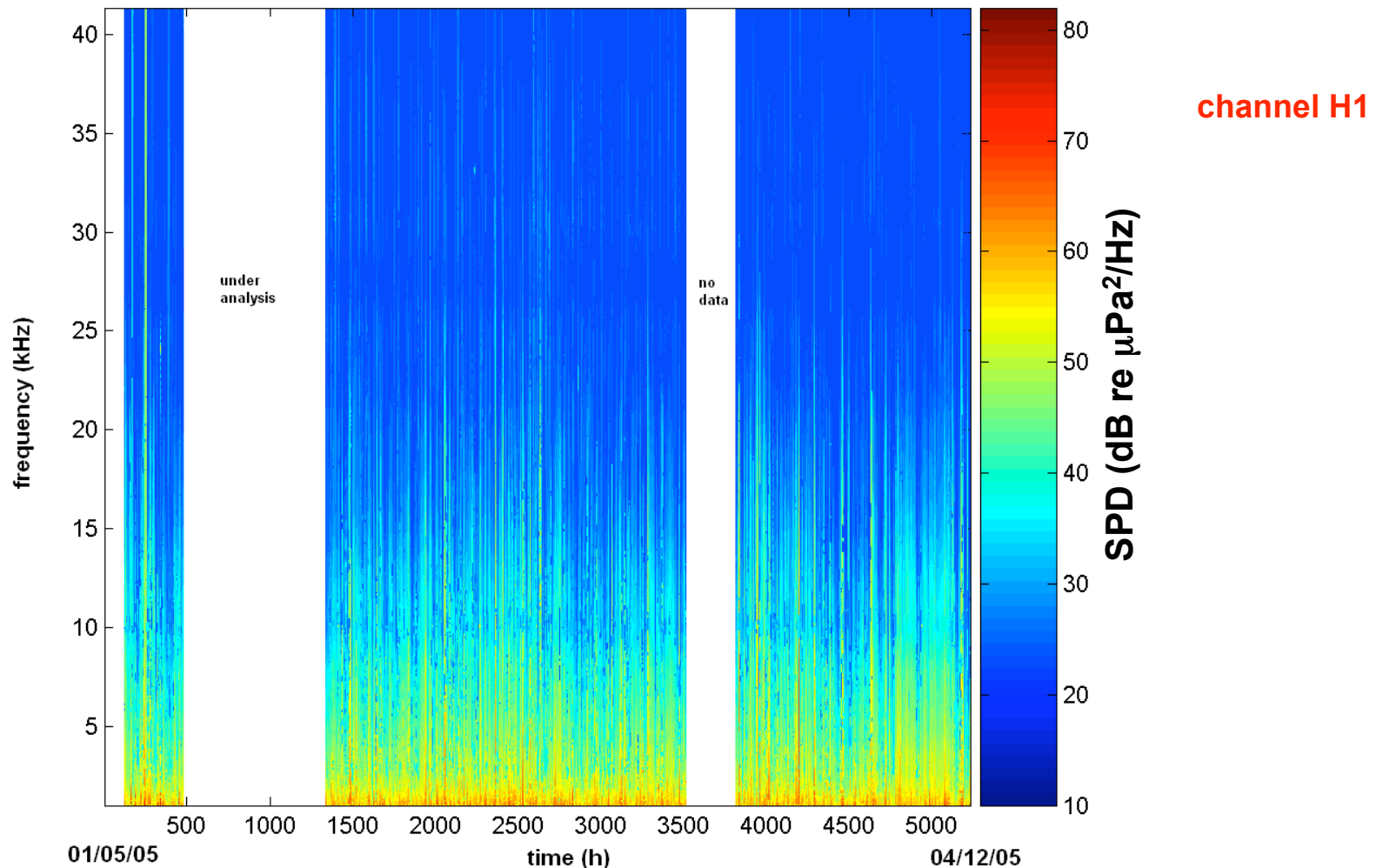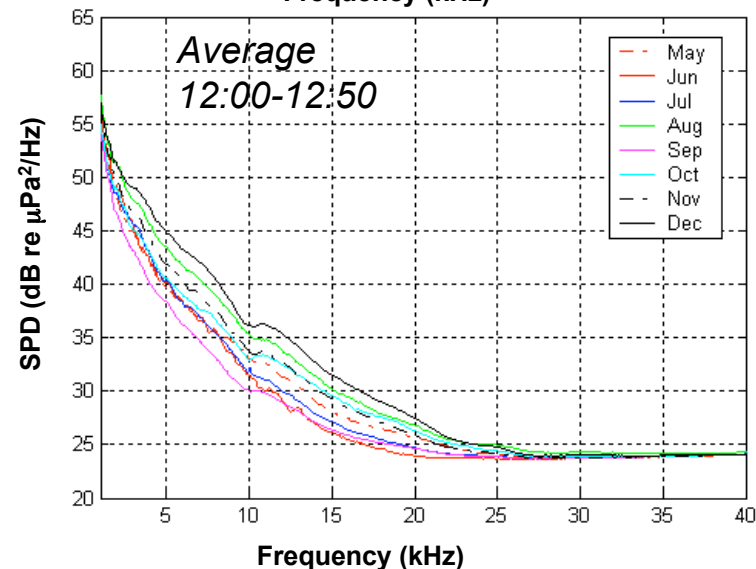
channel H1

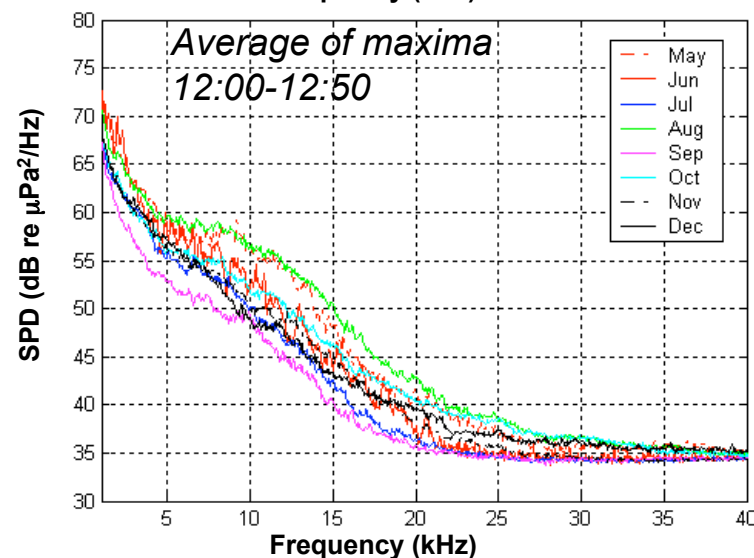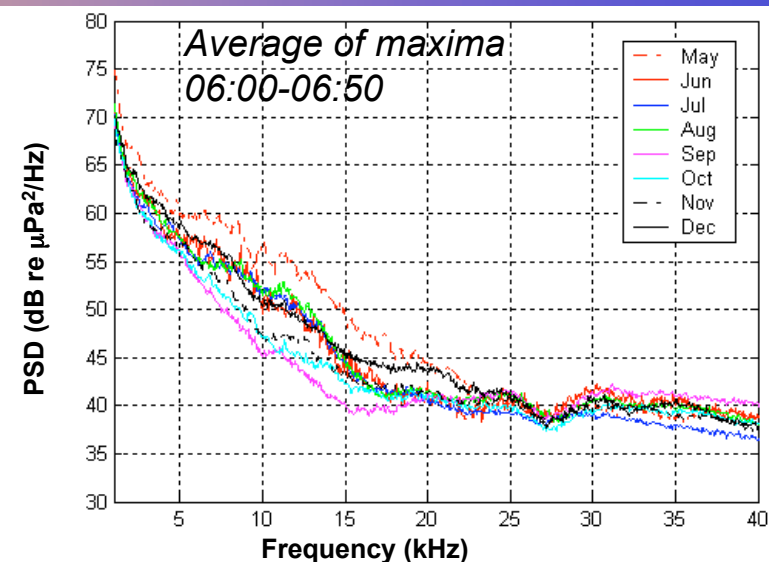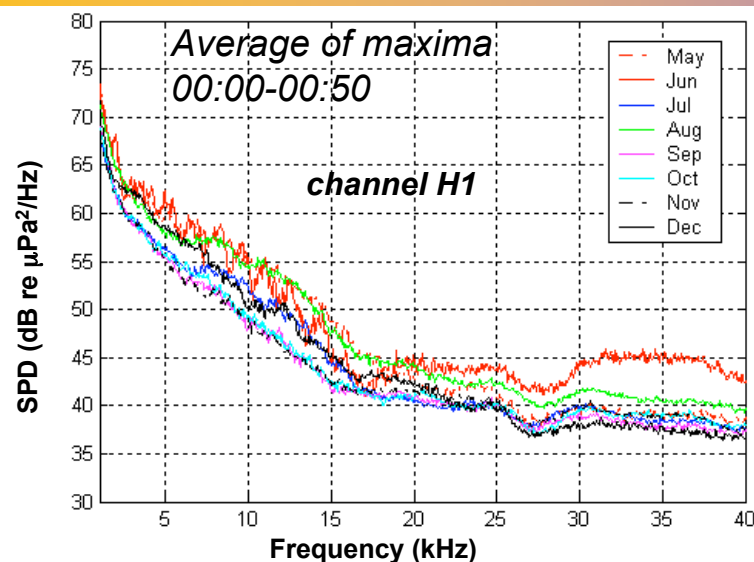| Month	# files
May	350
Jun	120
Jul	738
Aug	744
Sep	563
Oct	602
Nov	720
Dec	336
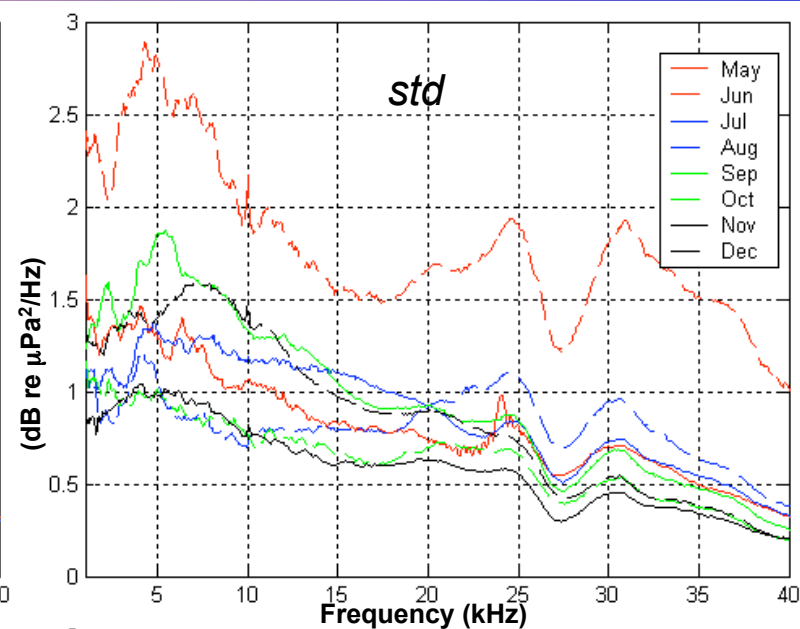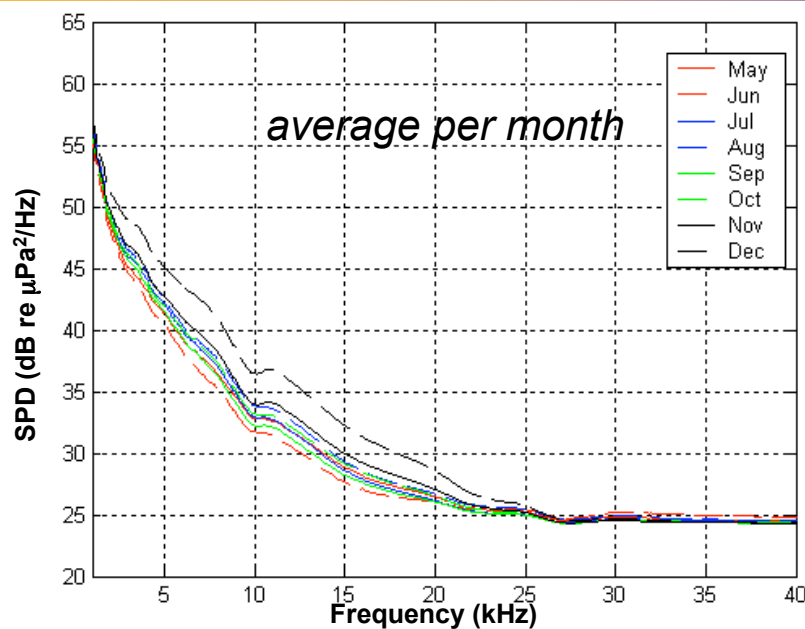
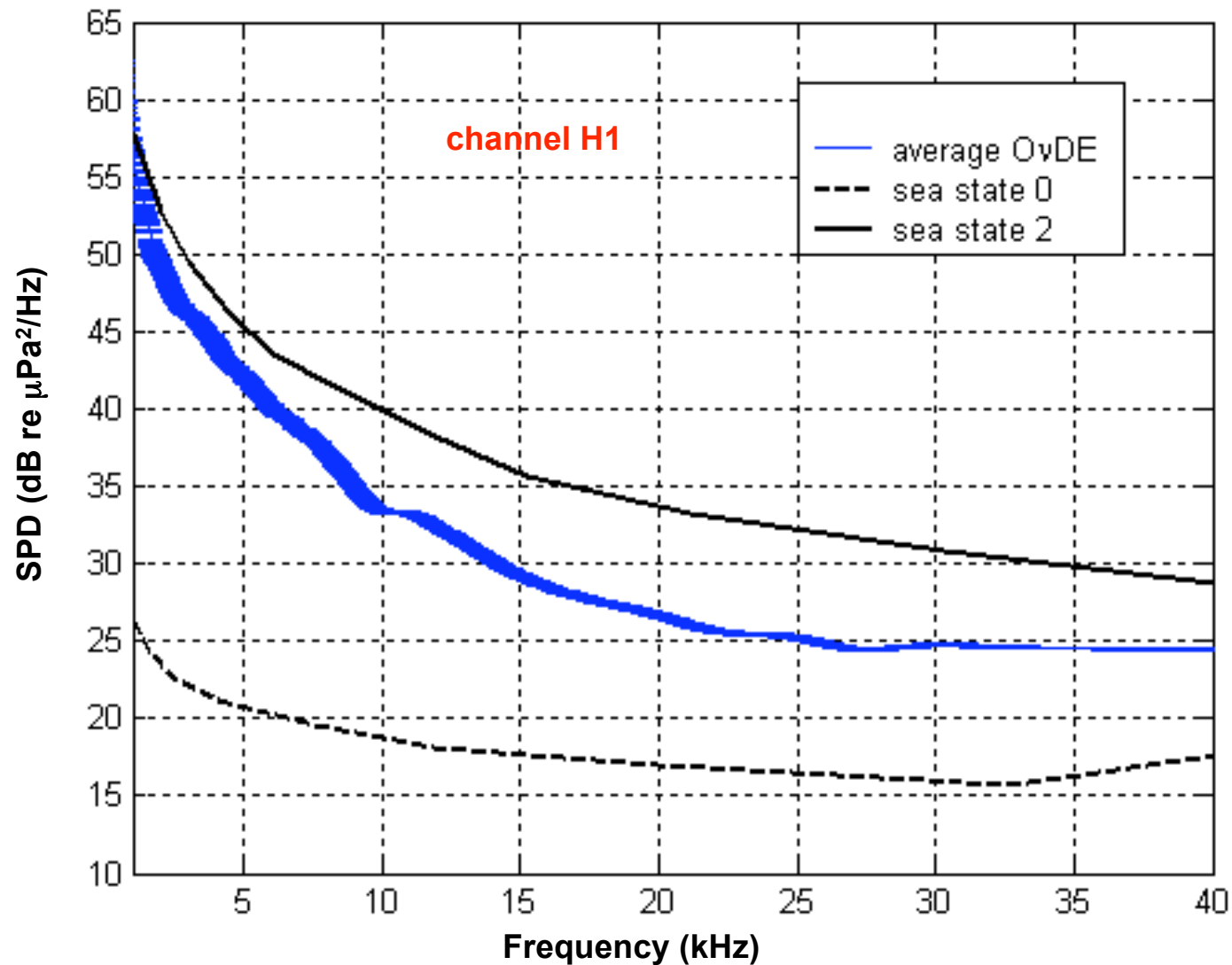**About 175 files per hour**
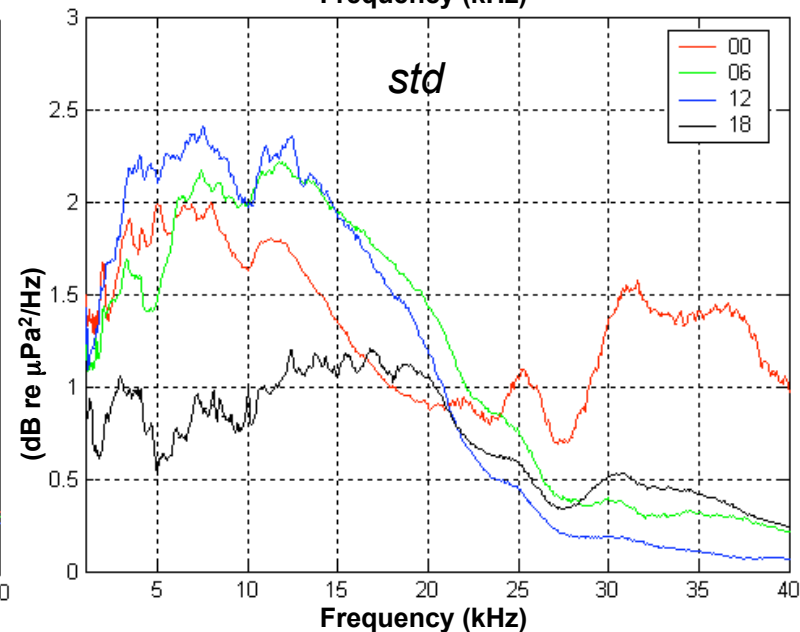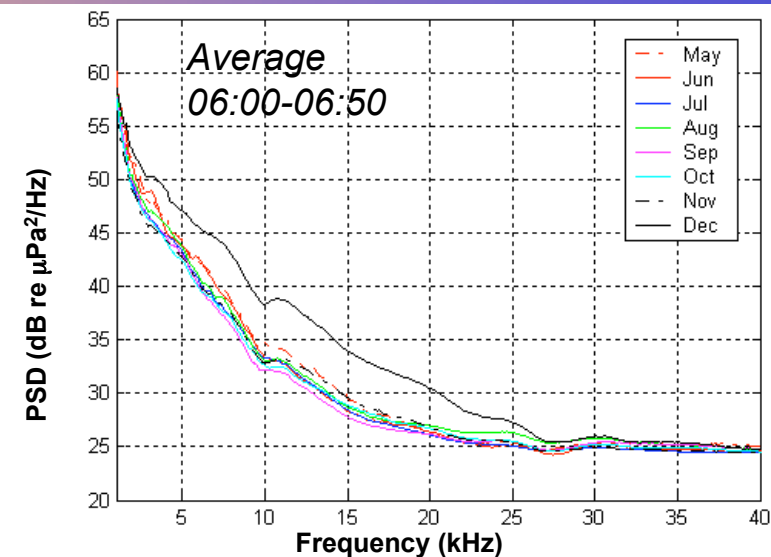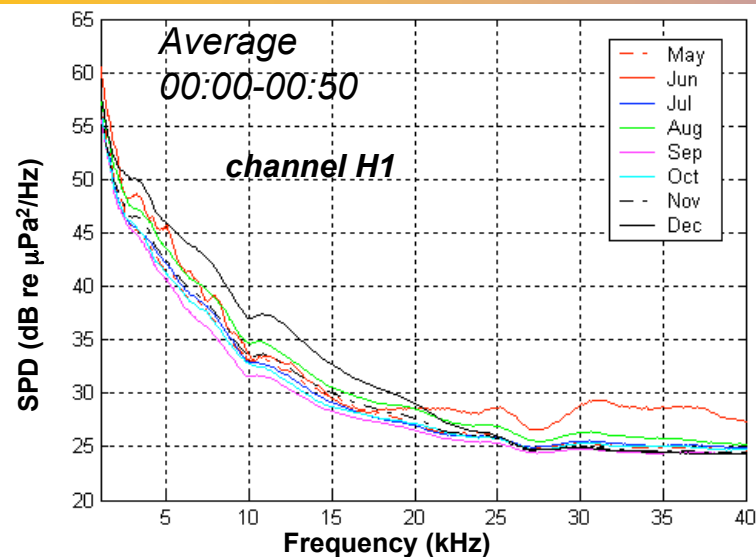
**Since average can be influenced by impulsive intense signals
Look also at maximum (done) , median and 90% percentile (under analysis)**
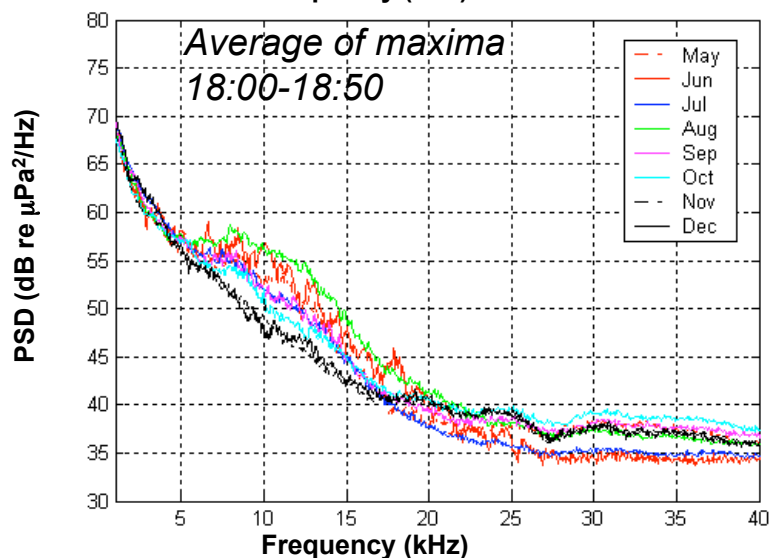
Maximum noise levels are about 10-15 dB higher than the average ones

Fluctuations of noise level are strong below 20 kHz.

At higher frequency SPD = 24±1 dB re μPa^2/Hz (assuming –175 dB sensitivity)
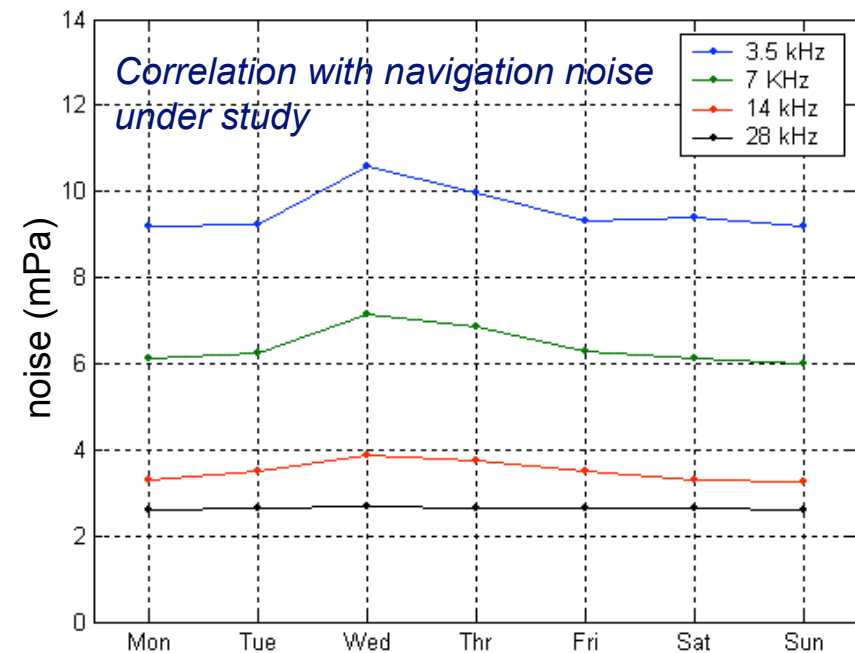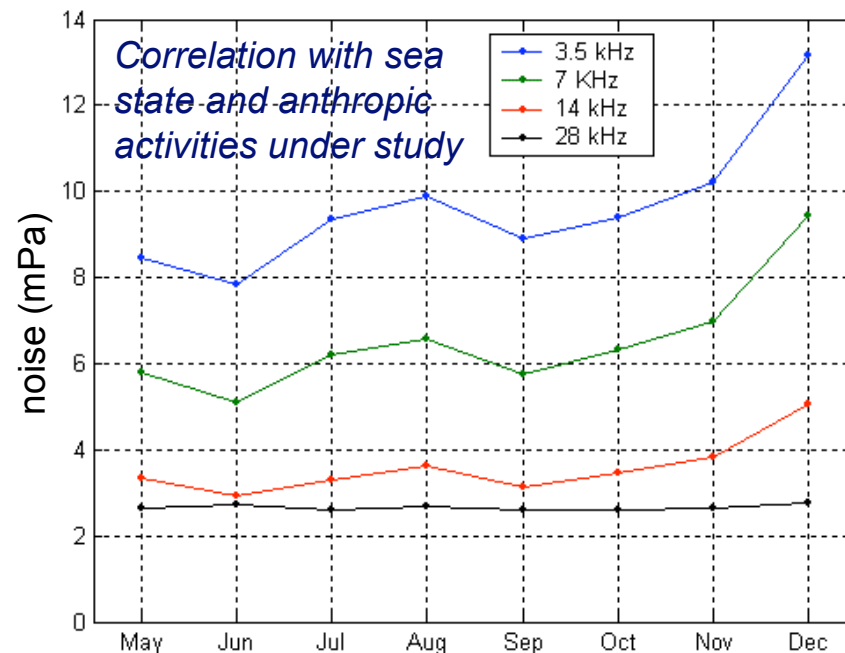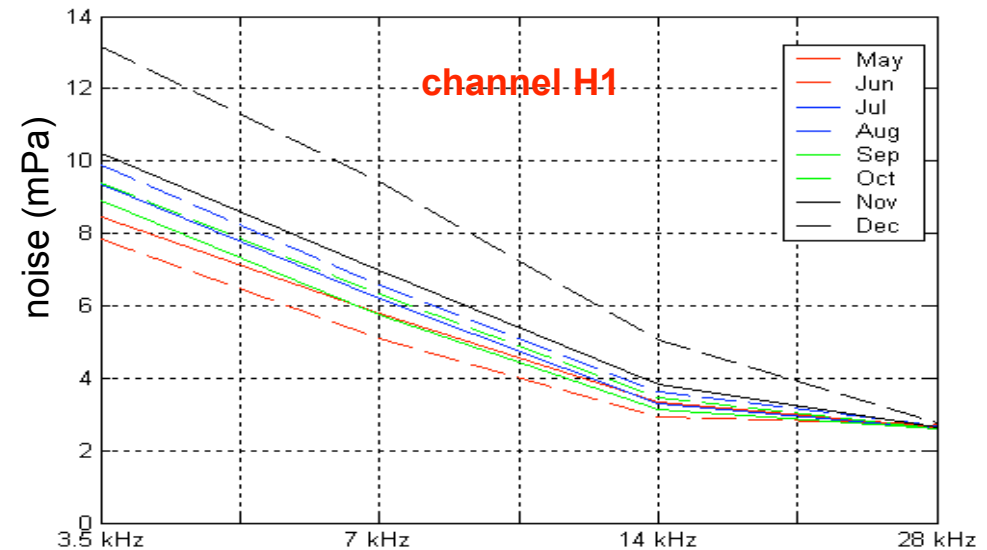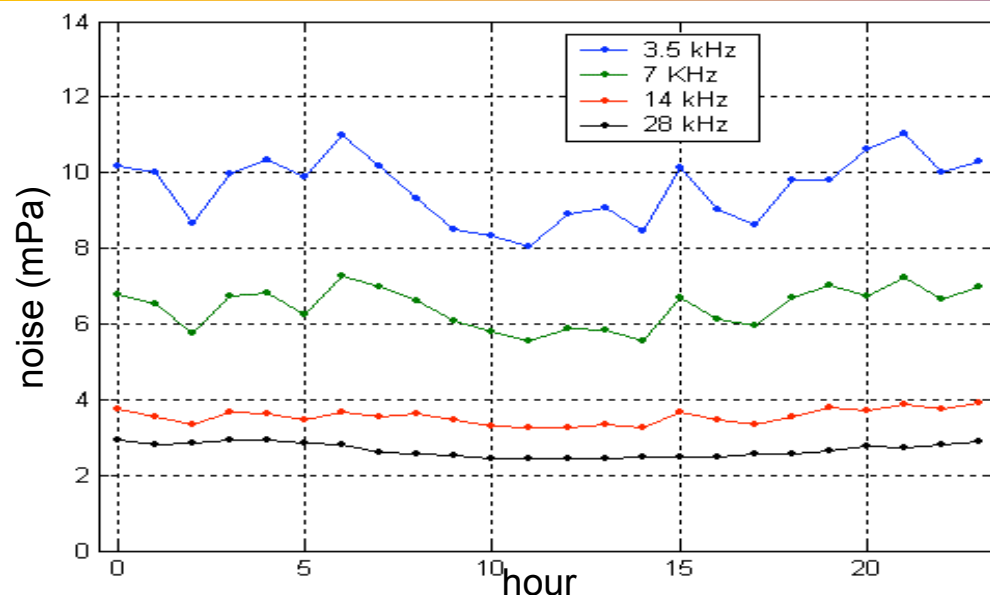
Noise integrated in octave bands

Central band values: 3.5 – 7 – 14 – 28 kHz

Band limits: [2.5 5] [5 10] [10 20] [20 40] kHz

- **Increase of noise in summer and winter**
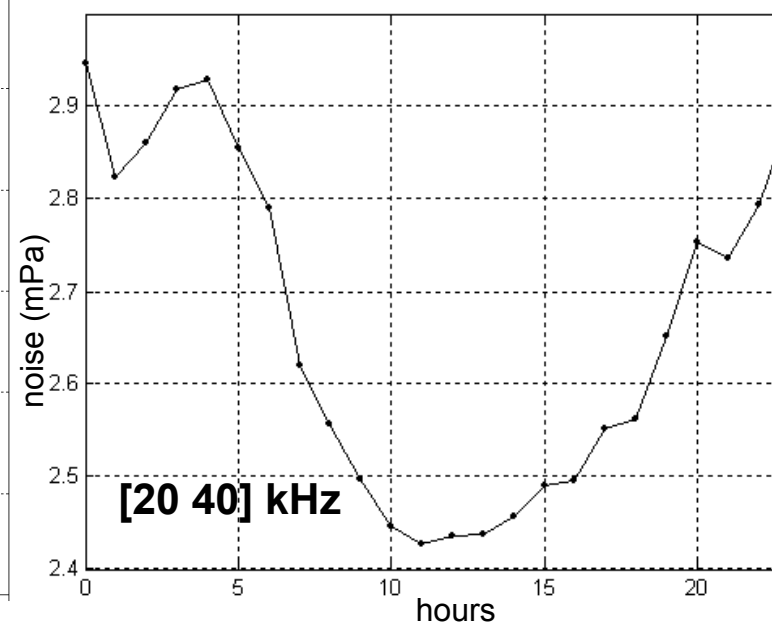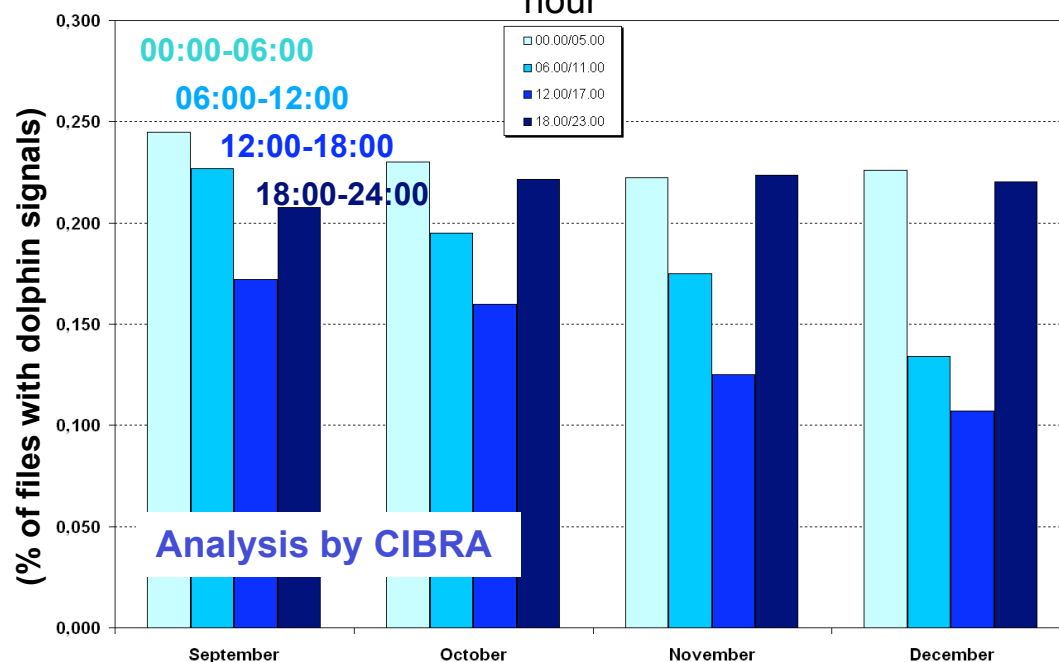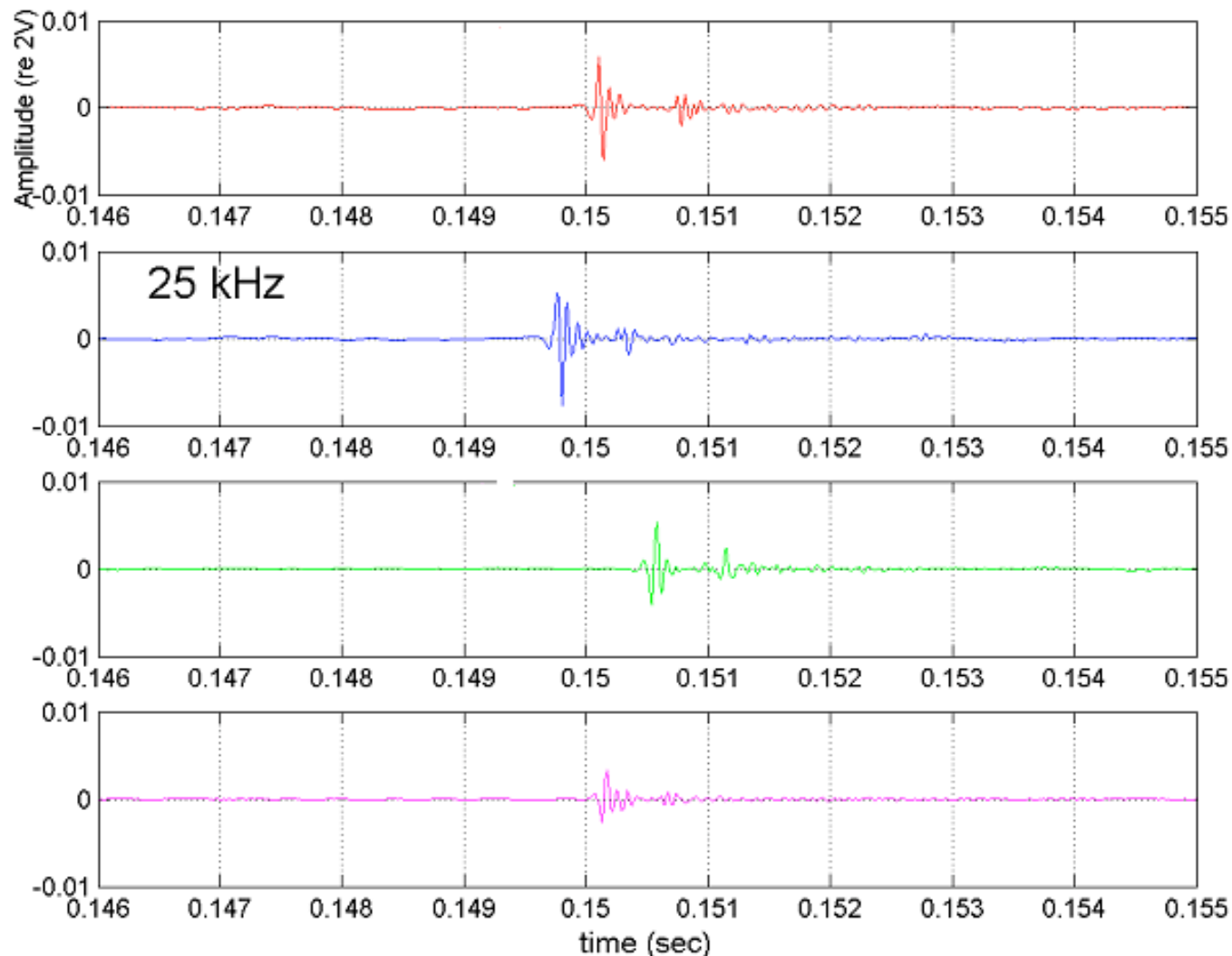- **Increase of noise on Wednesday and Thursday**

Increase of noise (mainly at high frequencies) during night hours:

Noise variations at high frequency are probably correlated to dolphin clicks during hunting hours

channel H1

00:00-06:00
06:00-12:00
12:00-18:00
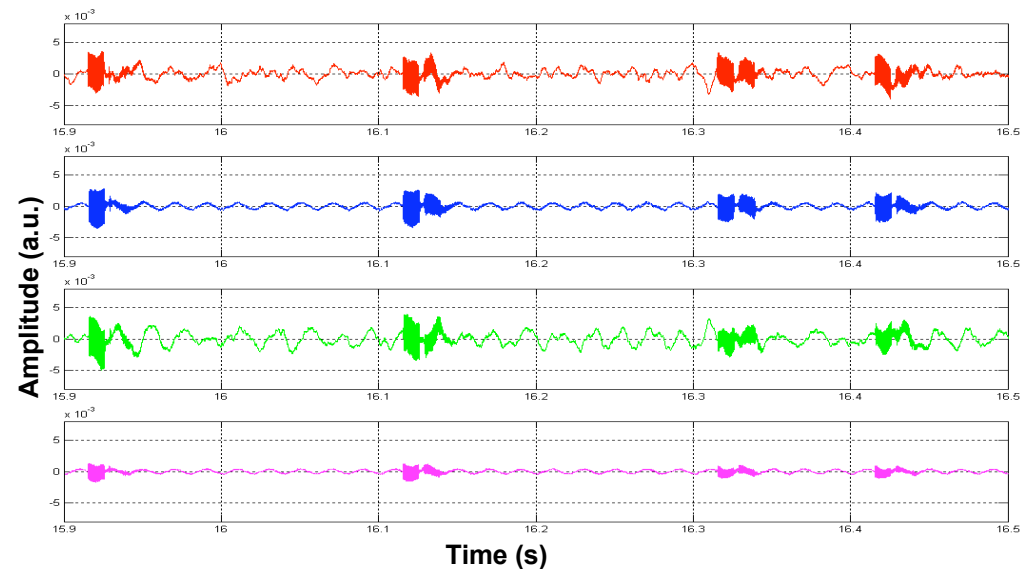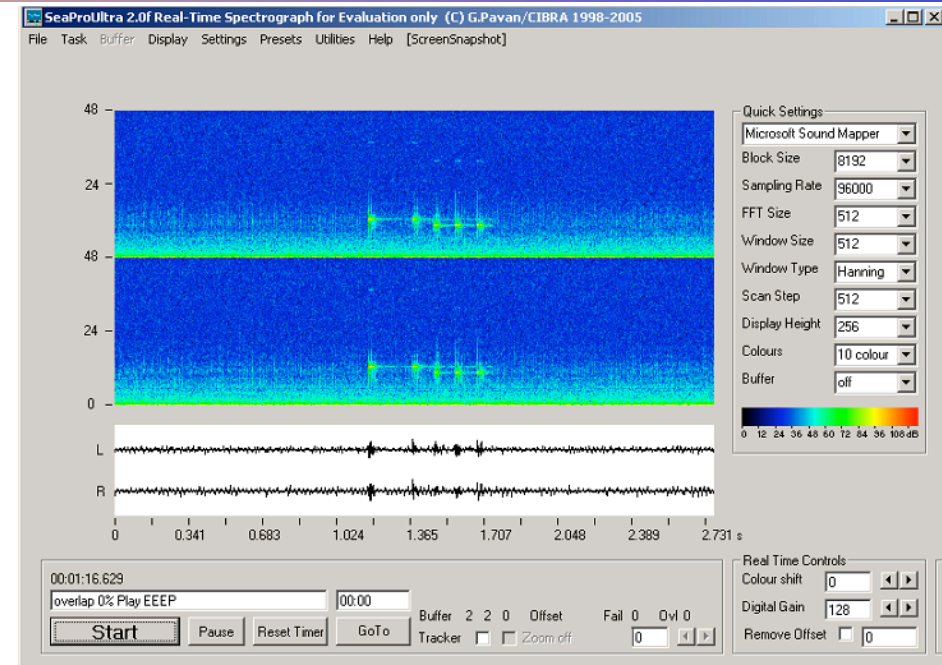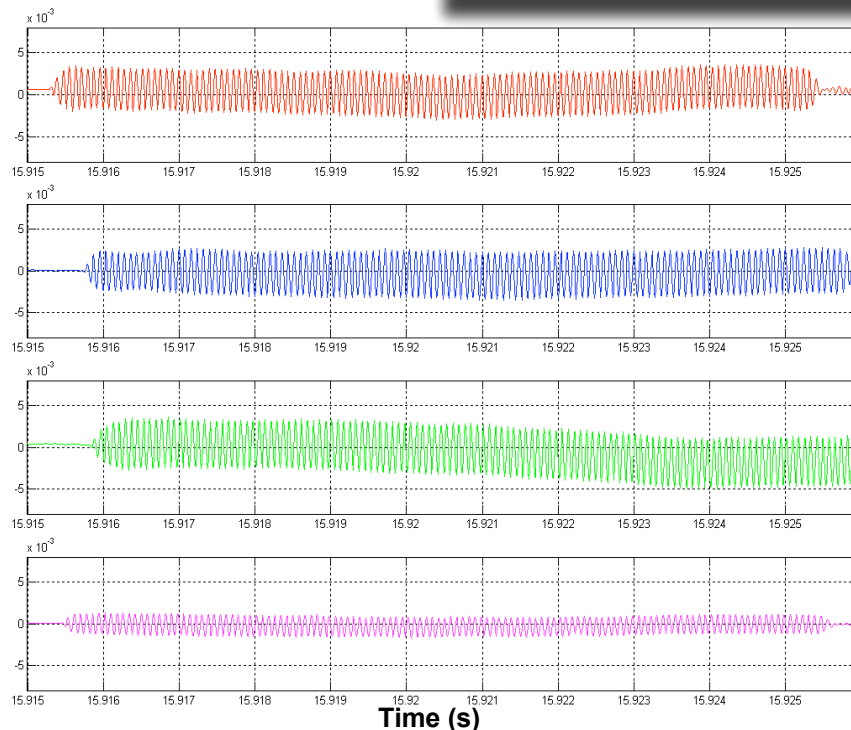18:00-24:00

Analysis by CIBRA

[20 40] kHz

Event recorded on May 1 at 19:00

The exact position of the four hydrophones is known, this information will be used to locate the source position (direction)

Calibrated signals were emitted on-board the Thetis vessel (September 2005) using an acoustic transceiver in order to check source tracking algorithms.
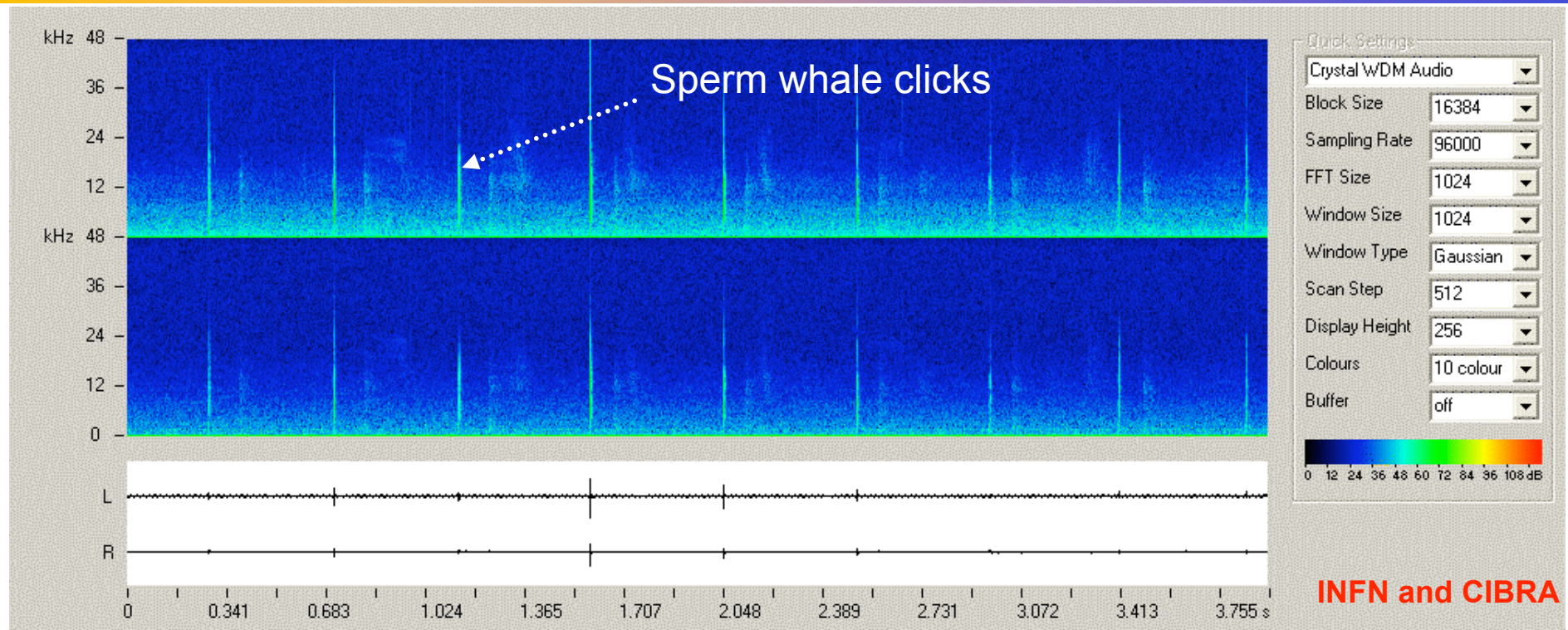
The detection of such sounds indicates presence of whales more frequent than previously believed.

Long term observation and signal tracking will allow the determination of marine mammals presence and seasonal routes.
By analyzing "click" details it is possible to assess the size and the sex of the animals.

Within the end of summer OνDE will be disconnected to install NEMO Phase1

- **ROV mateable connectors available on the Junction Box (JB)**
- **DWDM data trasmission (no bandwidth problem)**

The Test Site will remain an excellent site for prototyping activities

The NEMO JB

The NEMO mini-tower
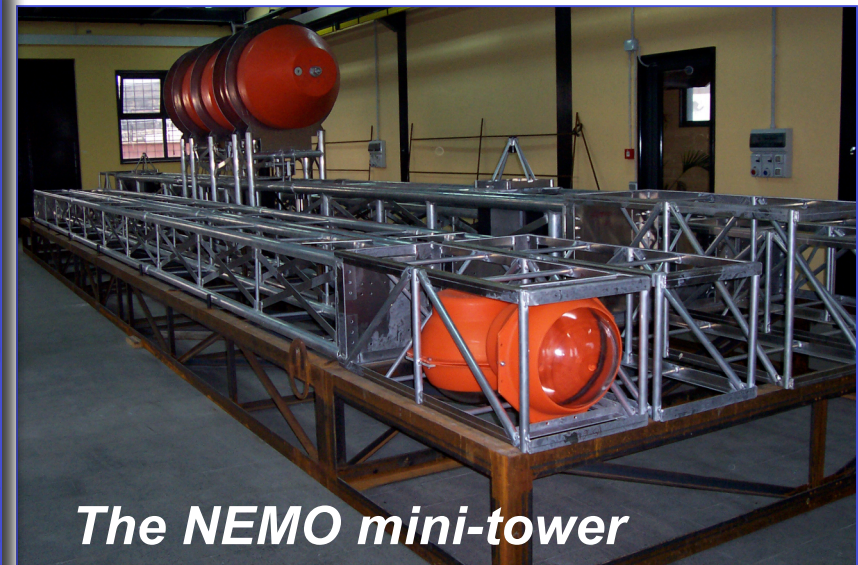
...and soon NEMO Phase 2 in Capo Passero at 3500 m depth !

Status:

- **The first step of "NEMO Phase 1" construction was successfull**

- **A continuous stream of acoustic data from 2000m depth is monitored on shore since Jan 23. Data recording is performed for 5' each hour.**

- **First results (using 1 channel assuming –175 dB sensitivty) :**

  - **Acoustic noise is less than "*Sea State 2*" and variable at *f* < 20 kHz**

  - **Average PSD of acoustic noise at *f* > 20 kHz is ~25 $\mu Pa^2/Hz$**

  - **Hourly, daily, and monthly variations observed**

    ($\rightarrow$ install the future detector far from ports and crowded naval routes)

Work in progress:

- **Correlation of noise with anthropic activities, biological signals, sea state**

- **Source position identification**

- **Classification of different noises**

Interdisciplinary activities:

- **Biological researches on marine mammals resident in the Gulf of Catania or passing through in their seasonal movements**