Very Large Volume Neutrino Telescopes

Amsterdam 10-13 October 2003

Parallel Session
Software

Overview over Mediterranean Water Properties

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INFN

Role of natural Seawater in a "real km^3" and in Montecarlo

G.Riccobene
LNS-INFN

Direct effects

Light absorption coefficient (λ)	number of Chernkov photons on PMT
Light scattering coefficient (λ)	timing of Chernkov photons on PMT
Volume scattering function (λ)	
Light refraction index (T, S, P, λ)	timing of Chernkov photons
Optical noise	spurious hits, PMT and electronics dead time

Indirect effects

Sound velocity (T,S,P)	position of PMTS
Sedimentation rate	light scattering + PMT temporary obscuration
Biofouling	PMT permanent obscuration
Currents	positioning
	increase bioluminescence
	reduce sedimentation

Mediterranean sites for the km3

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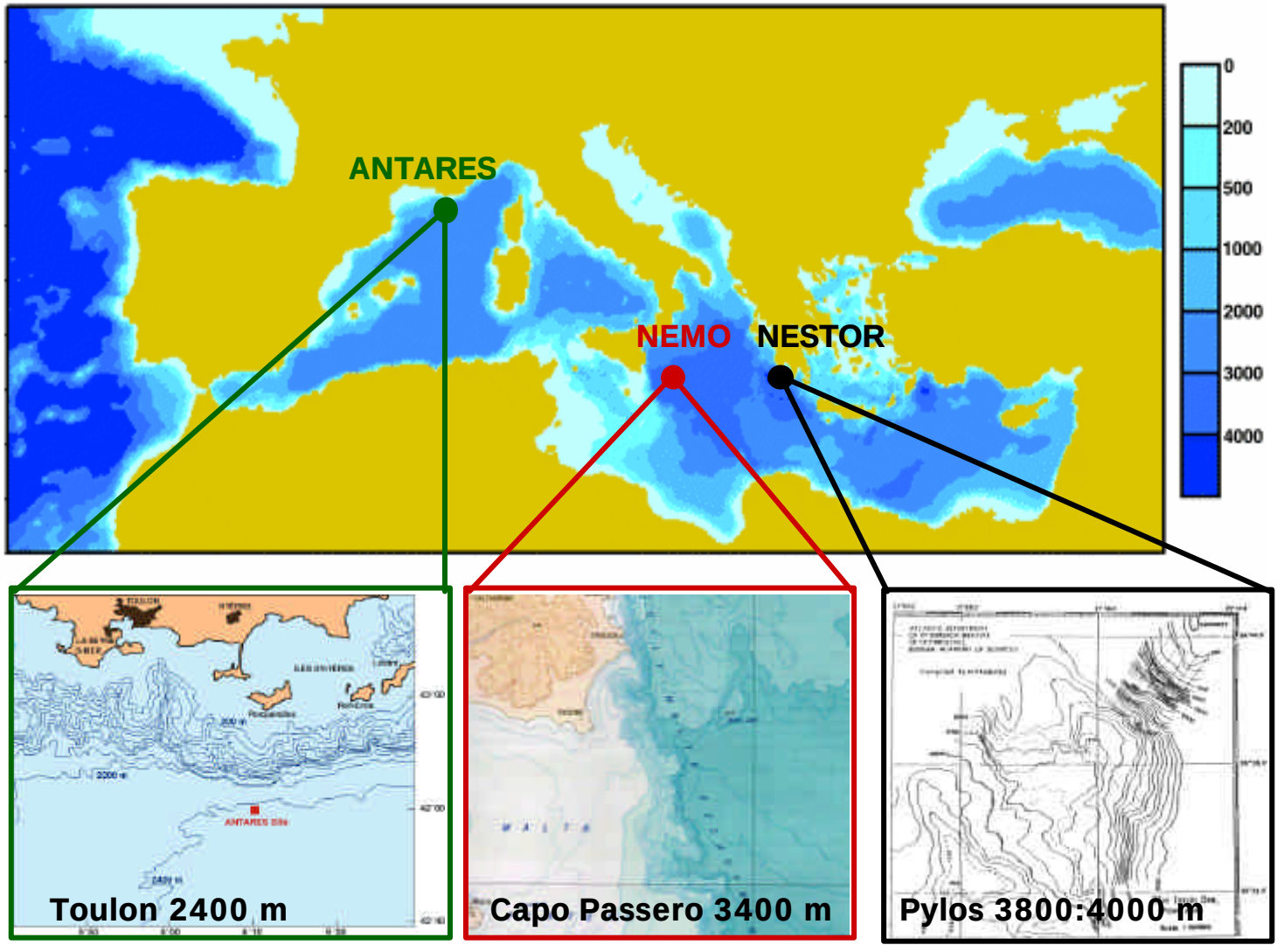

Depth and atmospheric Muon Flux

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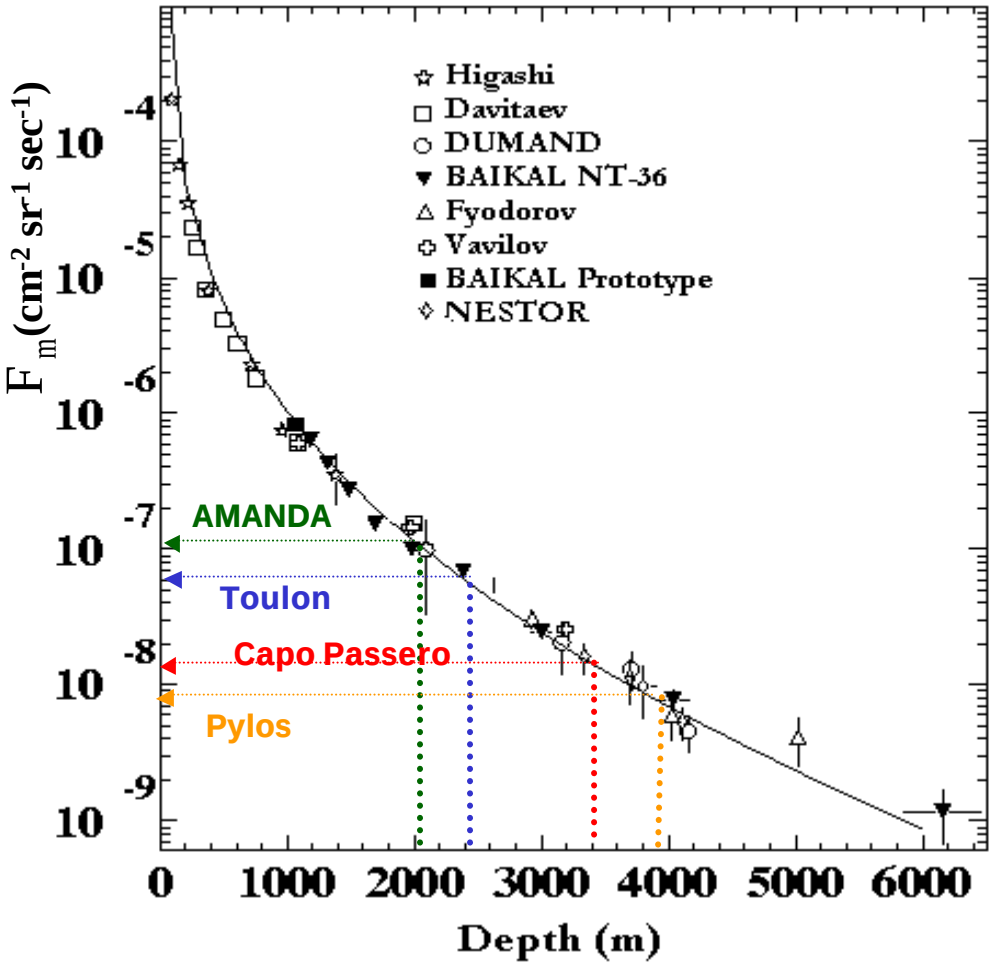

NEMO Site selection Activity

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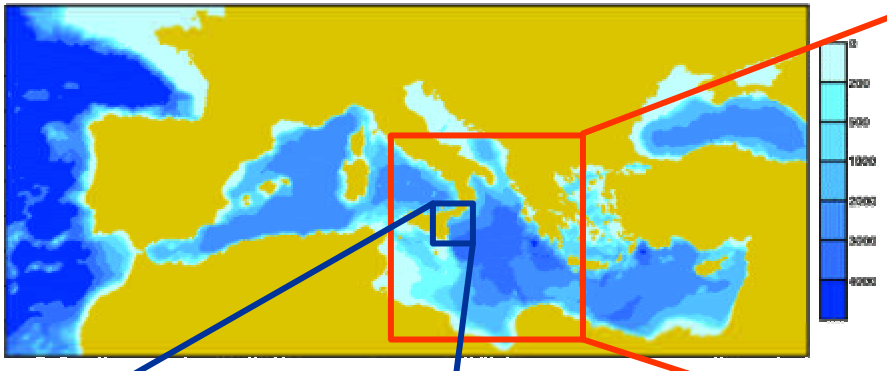

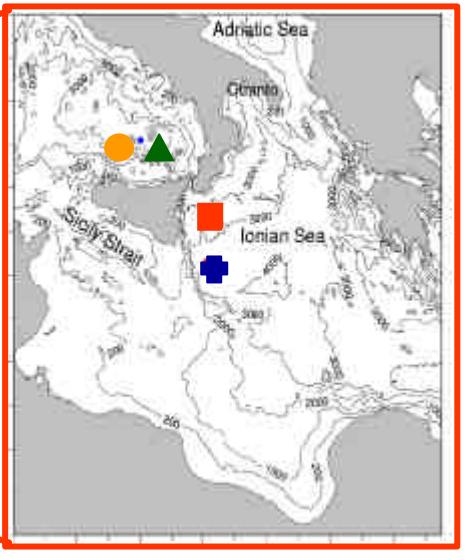

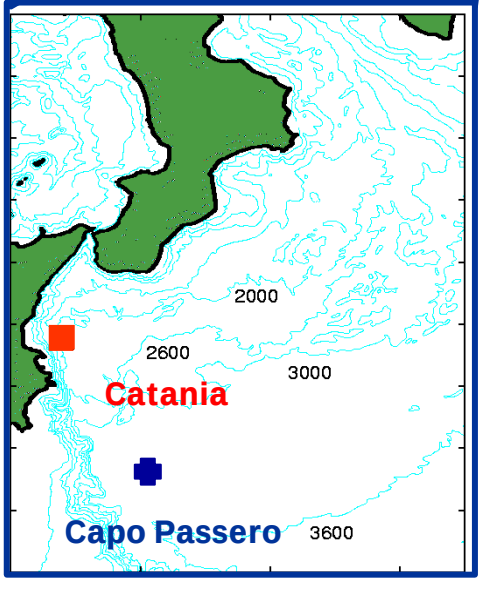

Catania"Test Site":
25km offshore
Capo Passero:
80 km offshore

- **Capo Passero 3350 m**
- **Ustica 3500 m**
- **Alicudi 3500 m**
- **Catania 2000 m**

The NEMO Collaborationinvolves several instututes experts of marine science.
NEMO collaborates with the Italian Military Navy and with the NATO-ScalancCen

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22 sea campaigns since 1998

- light transmission properties of deep sea water (AC9 transmissometer)
- optical background (custom devices)
- deep sea currents (RCM11 and RCM8 current metre) *data analysis OGS*
- nature and quantity of sedimenting material (Sediment trap) *data analysis IBM*
- seabed characteristics (cores and bottom profile) *data analysis CEOM-ENI*

Other sites explored

Lake Baikal, in collaboration with BAIKAL site evaluation group V. Balkanov et al. NIM 2002

Toulon (ANTARES site), in collaboration with ANTARES site evaluation group

AC9

AC9

Biofouling

Sediments

Optical background

The vessels for oceanographic campaigns

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Italian Military Navy

The Urania Corvette
60 m length

SH3D Helicopter

In situ measuremnet of water optical properties: AC9+CTD

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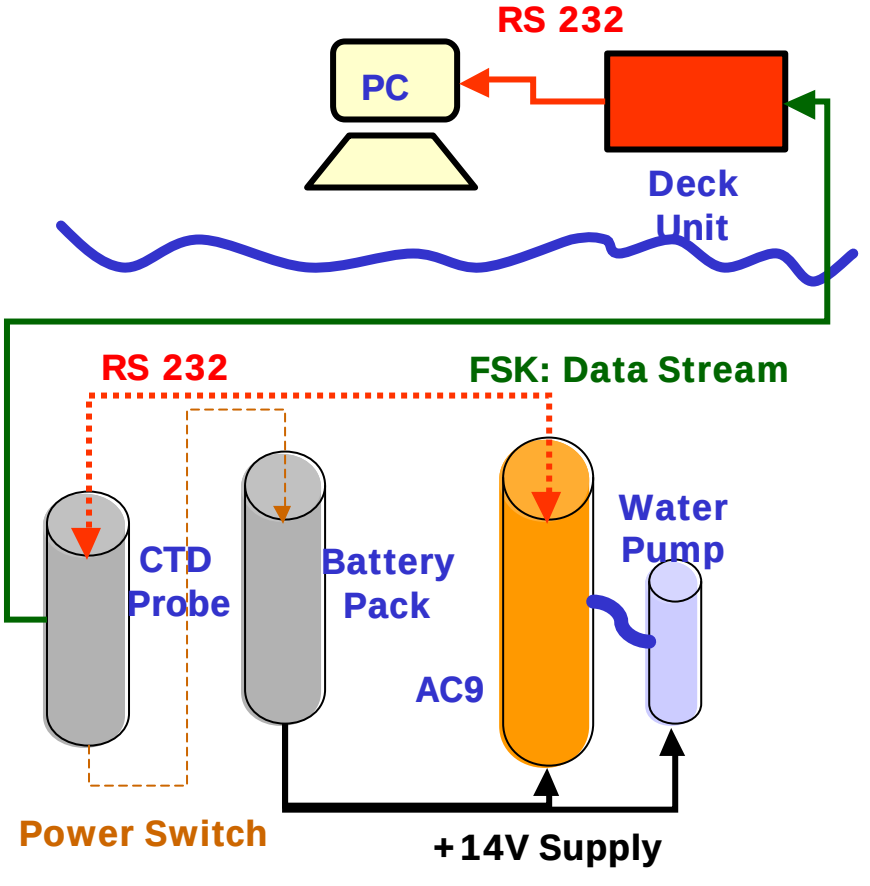
The setup used AC9 transmissometer+CTD measures oceanographical (temperature, salinity, pressure) and optical (absorption a and attenuation c coefficients at 9 wavelengths) parameters along the whole water column



λ = 412, 440, 488, 510, 532, 555, 650, 676, 715 nm

Deep Seawater Optical Properties near the Italian Coasts

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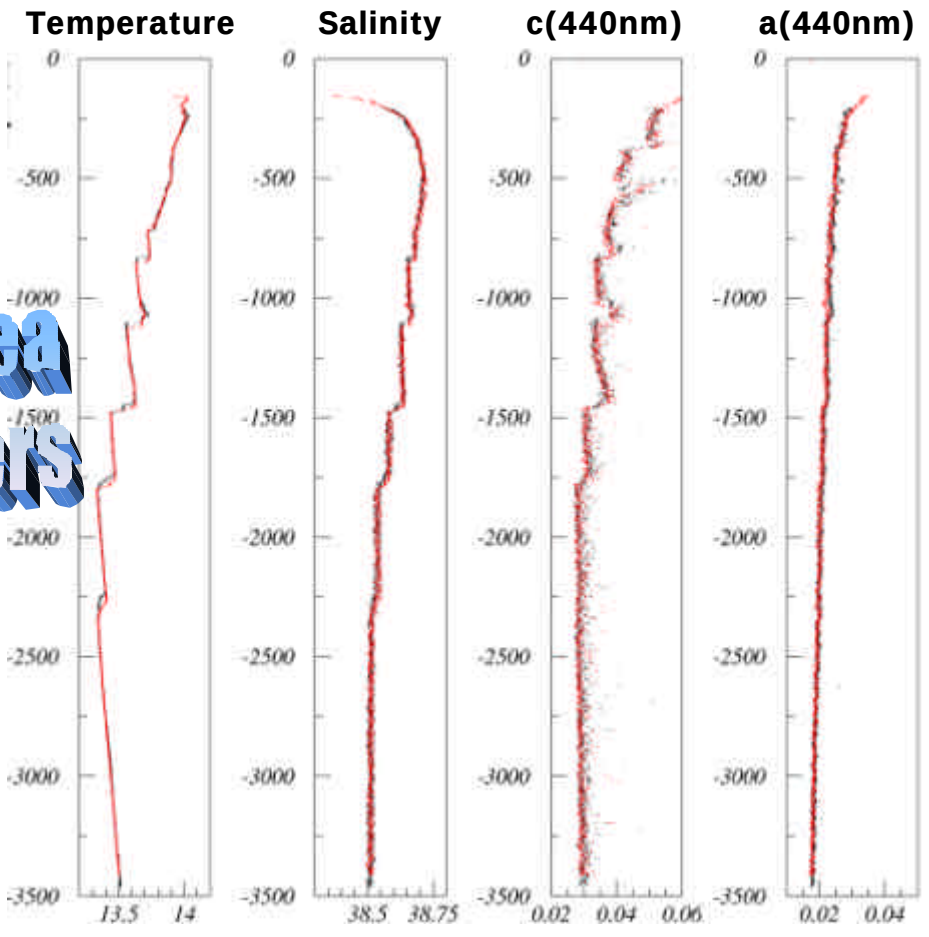
Altcudi: the Tyrrhenian Sea shows water layers

A.Capone et al., NIM 2001



The systematic error is due to the calibration of the instrument.

It has been evaluated to be: $\Delta a(\lambda) \approx \Delta c(\lambda) \approx 0.002 \quad m^{-1}$

Deep Seawater Optical Properties near the Italian Coasts

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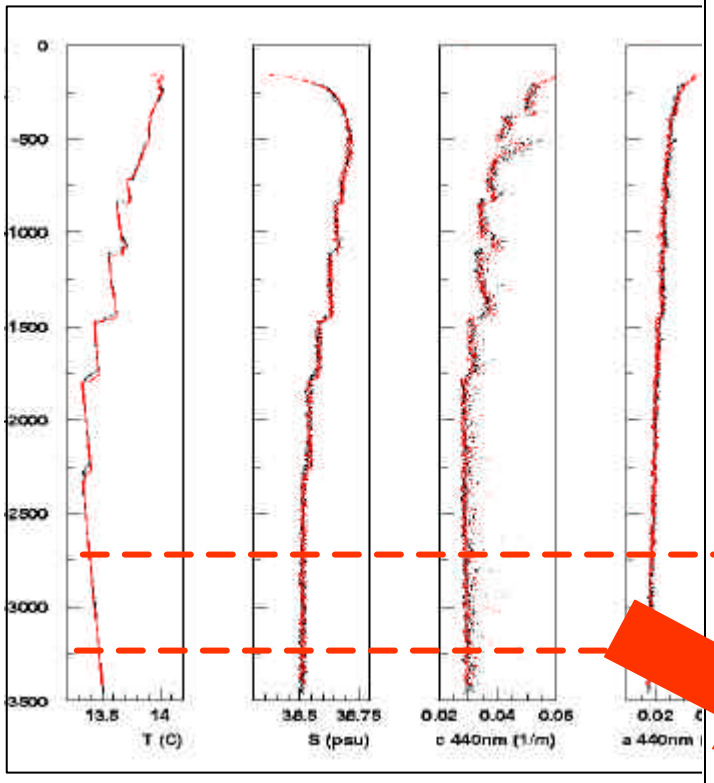
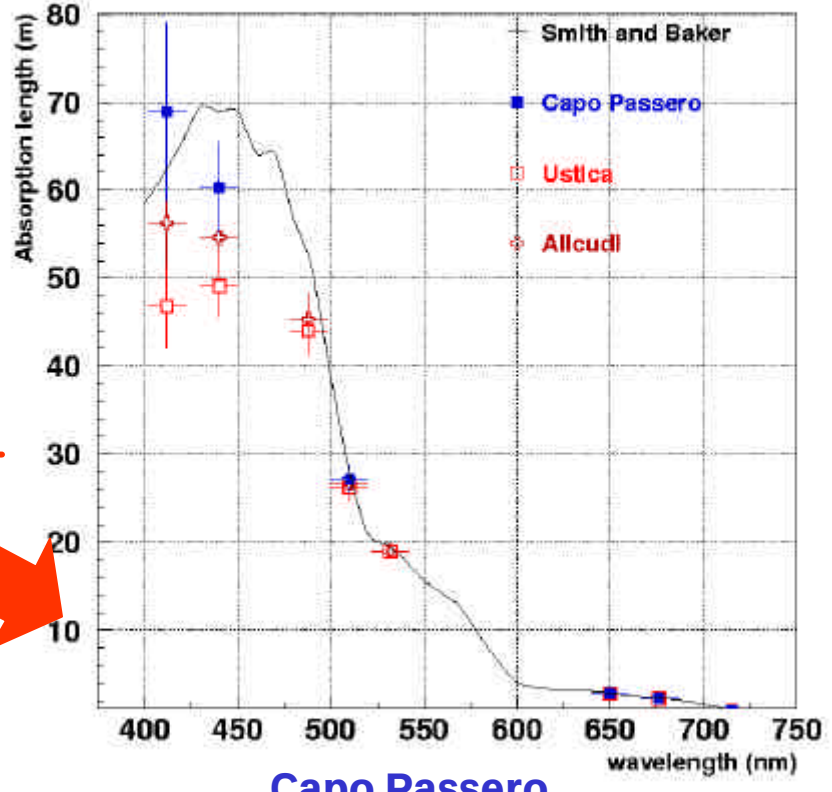


Sea Campaigns in December 1999



Capo Passero

shows optimal characteristics

Water optical properties: seasonal dependence

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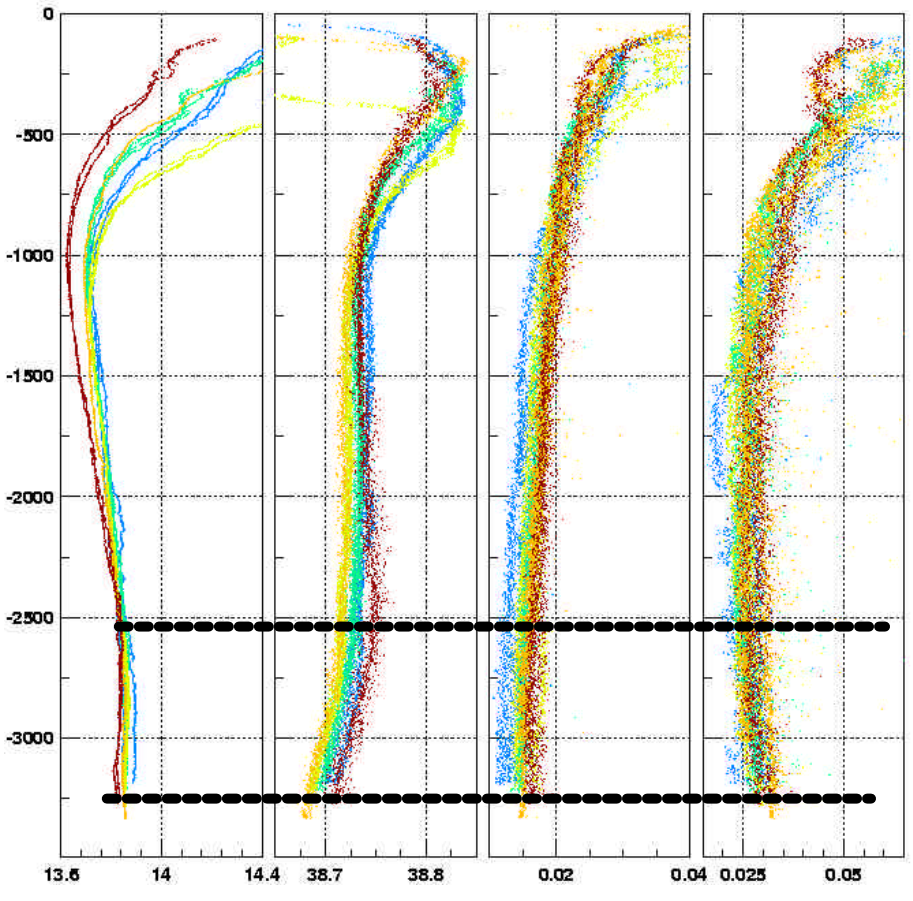

Seasonal dependence of oceanographical (Temperature and Salinity) and optical (absorption and attenuation) properties has been studied in Capo Passero

Variations are only observed in shallow water layers

Data taken in:

Aug 03 (2 profiles superimposed)

Aug 02 (3 profiles superimposed)

Mar 02 (4 profiles superimposed)

May 02 (2 profiles superimposed)

Dec 99 (2 profiles superimposed)

Seasonal dependece of optical properties in Capo Passero

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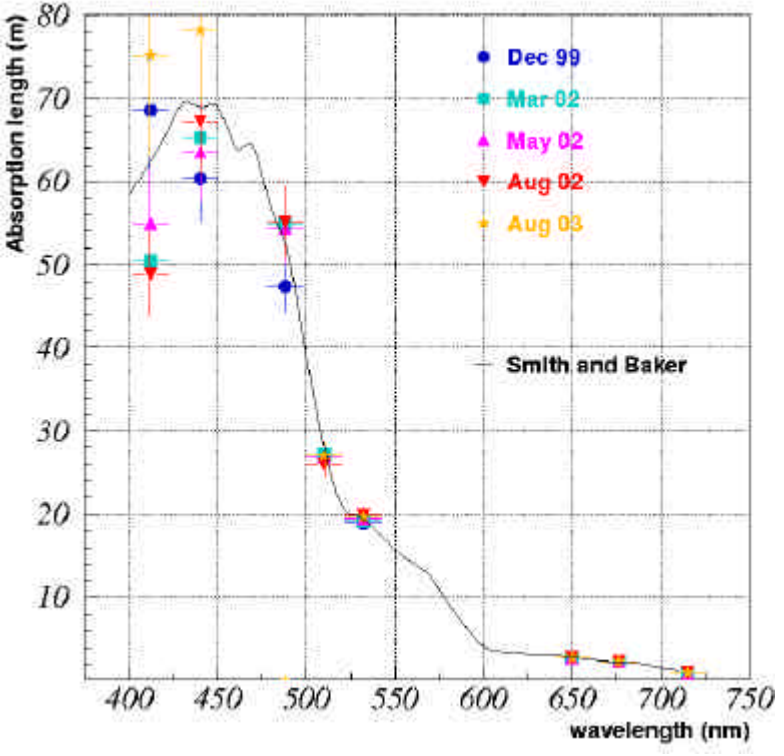
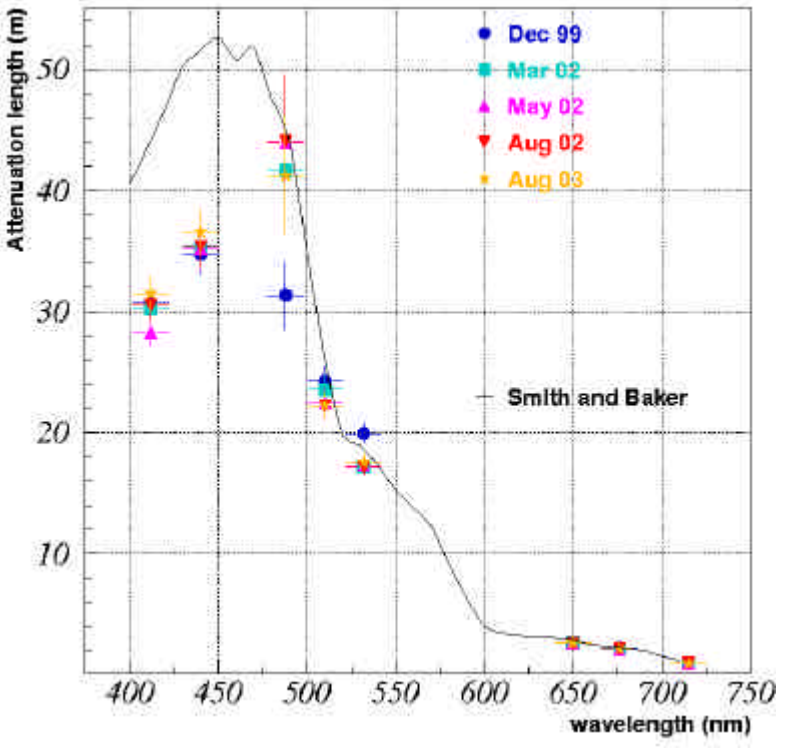
Capo Passero 2850-3250 m





Data points reperesent averages over each campaign

Optical properties of the NEMO Test Site (Catania)

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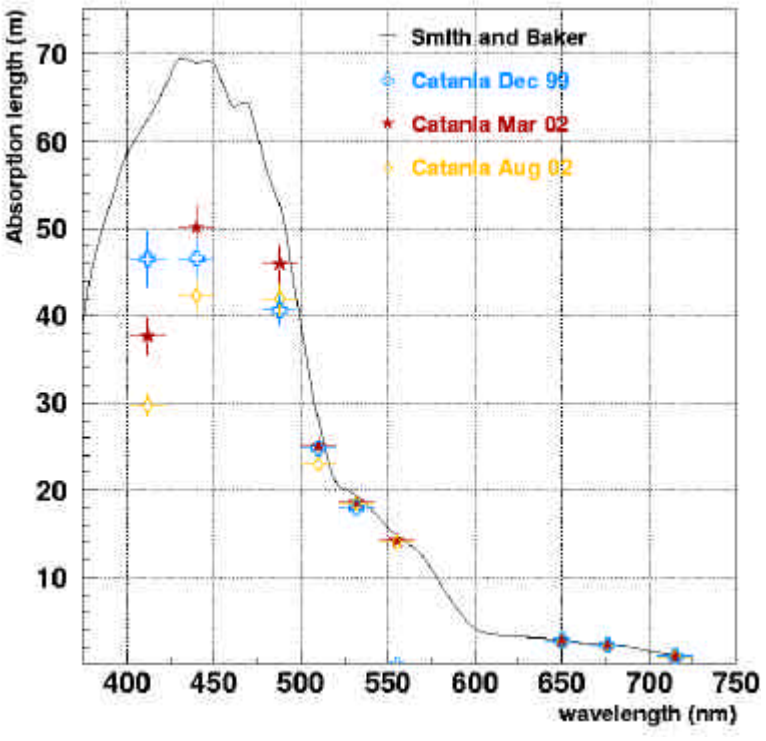
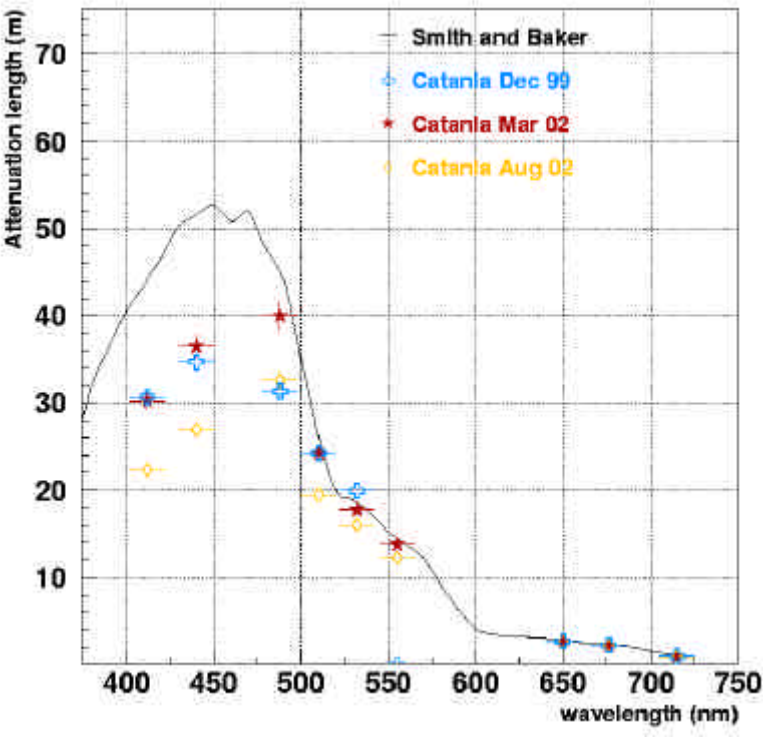
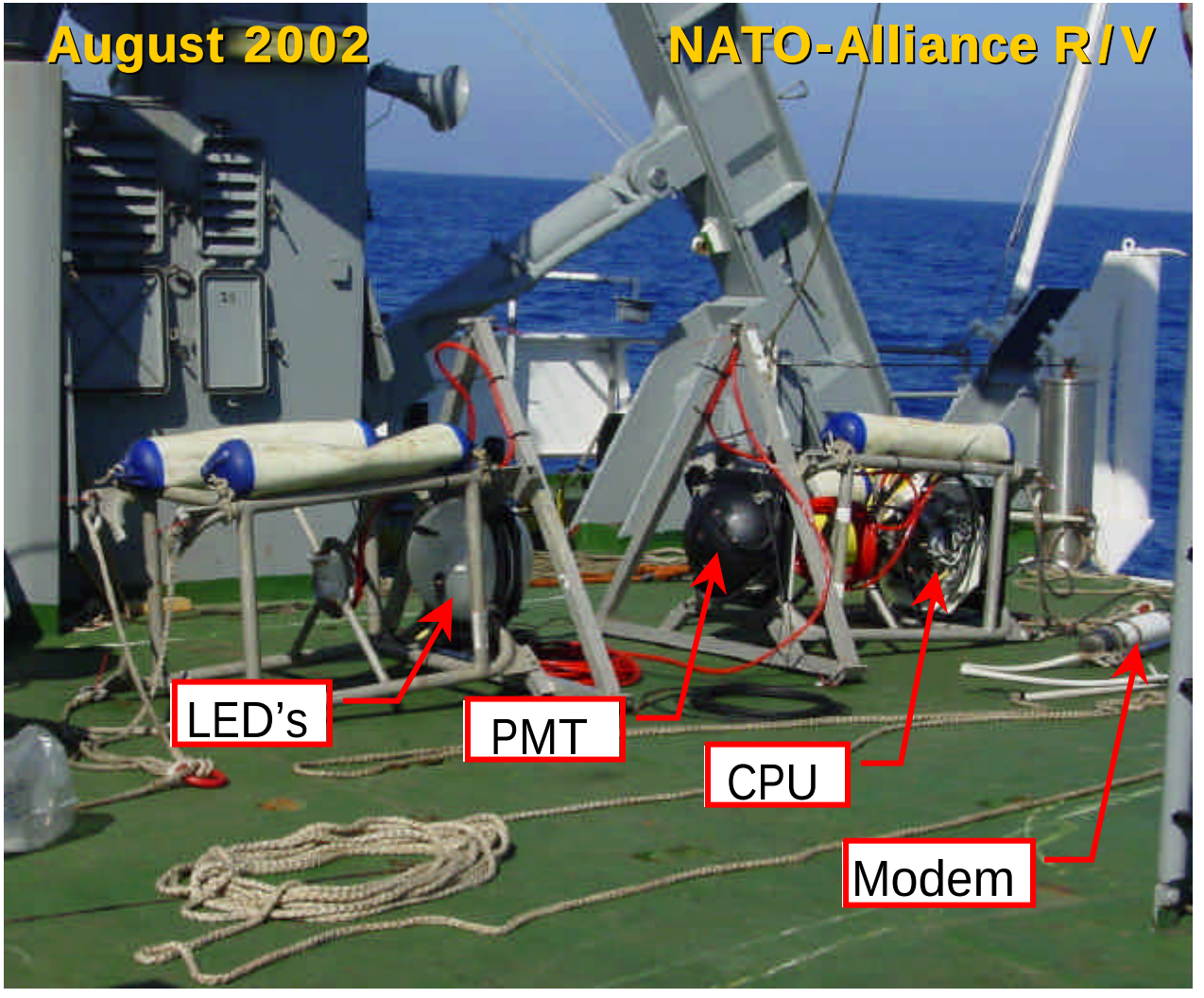
The NEMO Test site is located in a coastal marine environment close to the port of Catania





Profiles of the water column change as a function of distance from the Coast and with season



Test 3'

Joint Sea Campaign ANTARES -NEMO: Toulon

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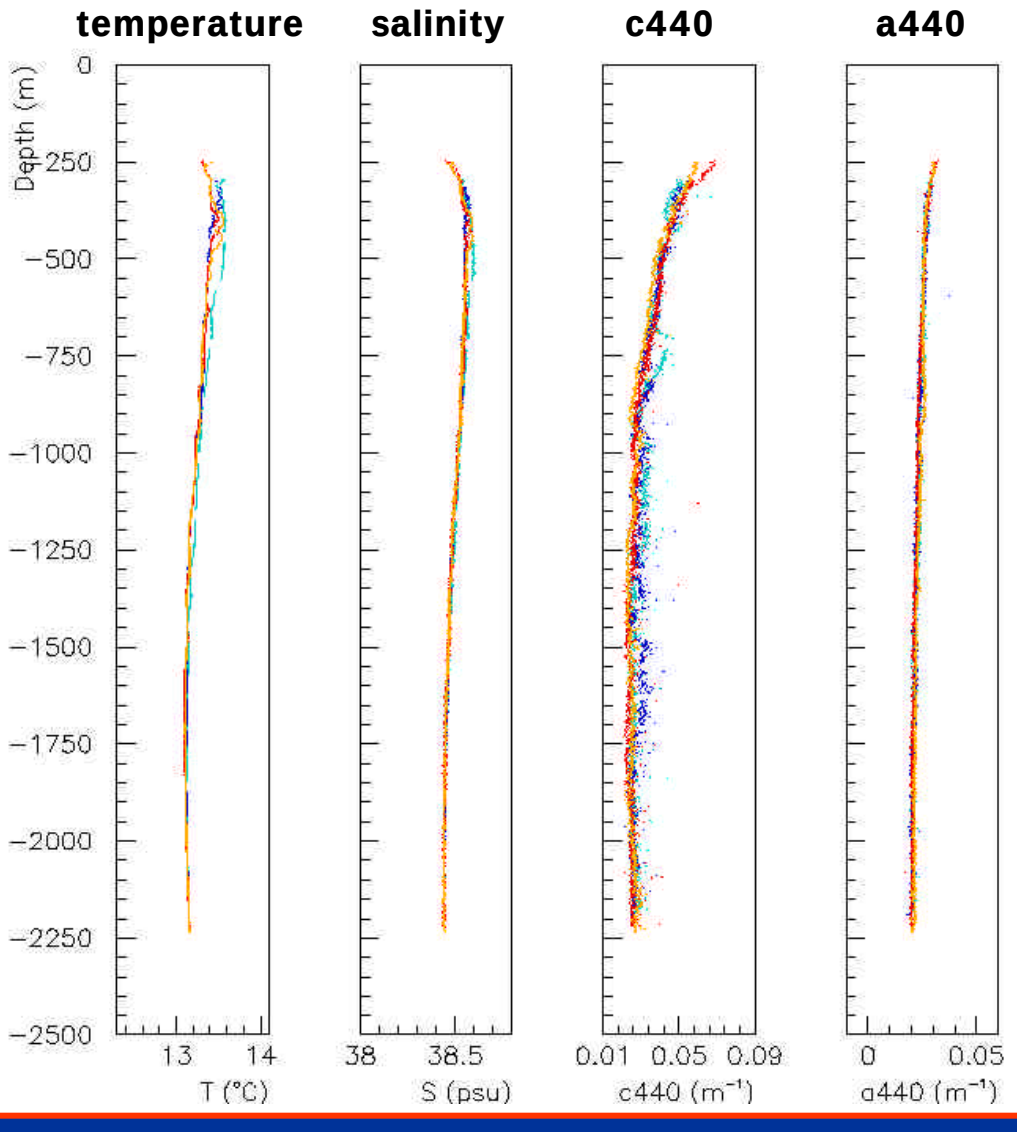
AC9 + CTD

Profiles of the water column in Toulon Region

Water is colder and less salty than in Capo Passero

At depth < 1750 m optical profiles of optical properties are not perfectly superimposable

(effect of distance from the coast?)



AC9+Test 3' data: Capo Passsero and Toulon

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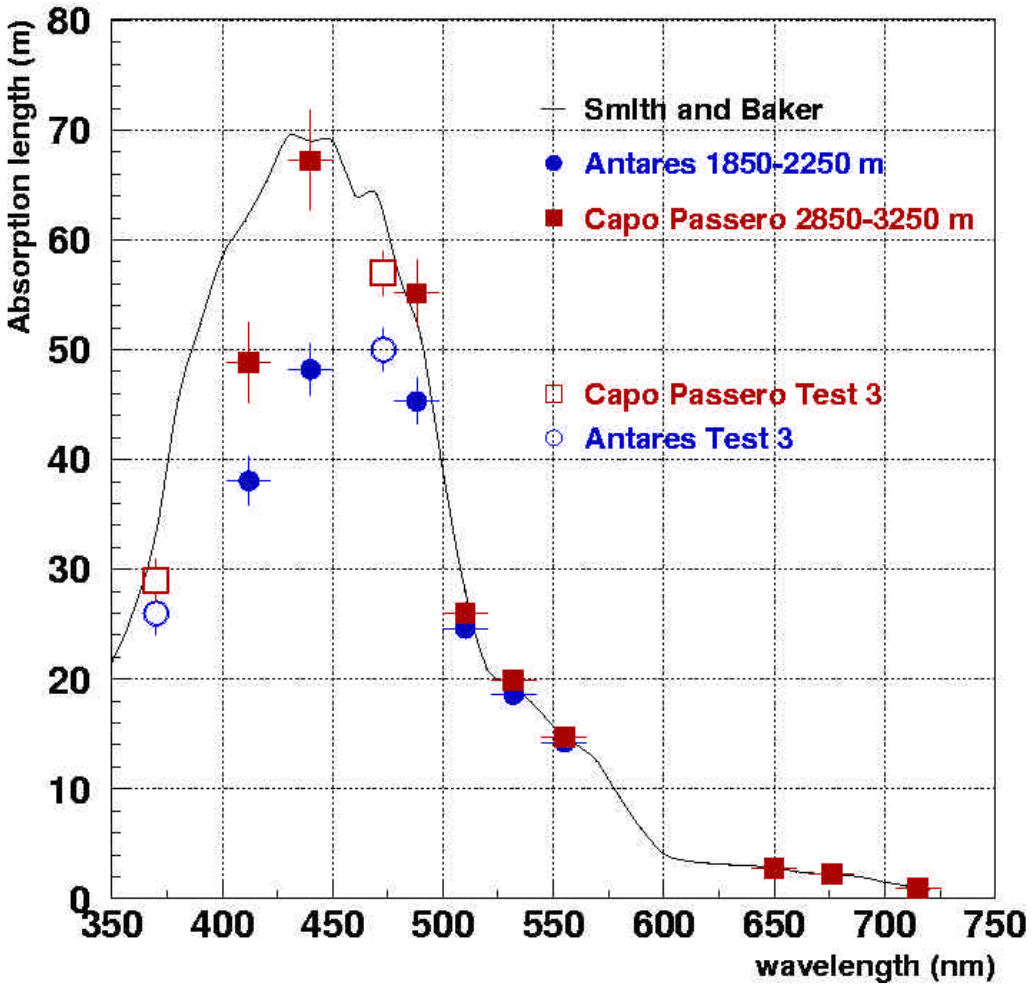

Test 3' Data courtesy of J-P Schuller

Water optical properties: Catania - Capo Passero - Toulon

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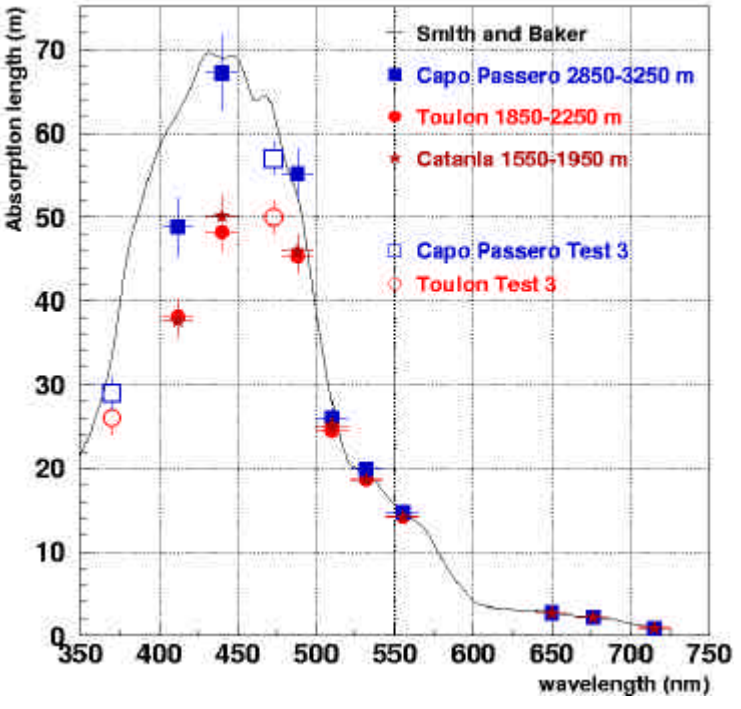
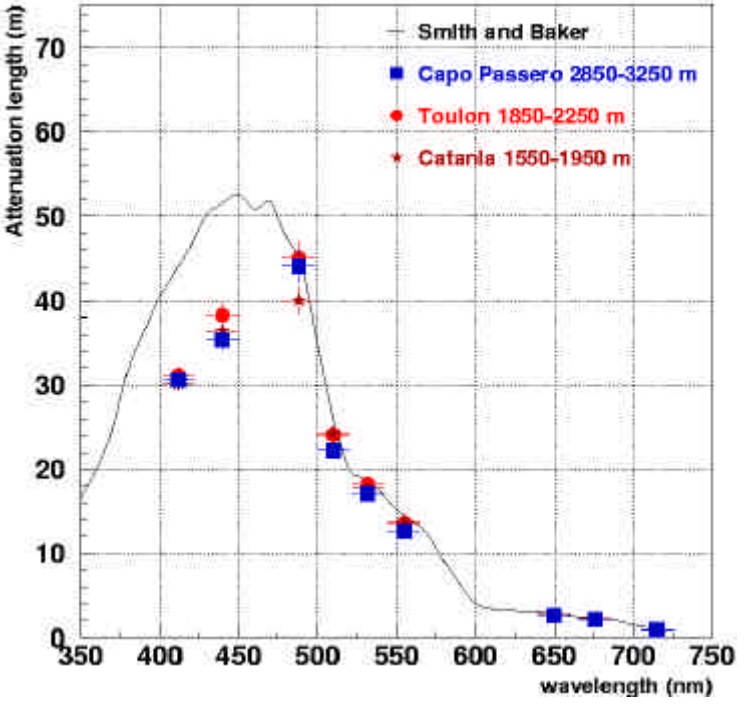
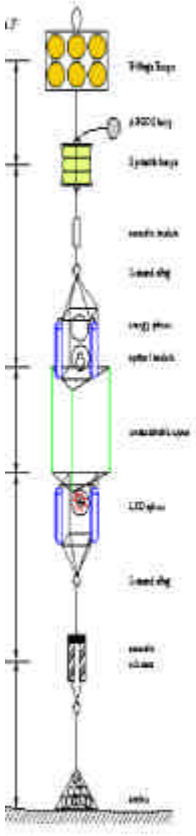
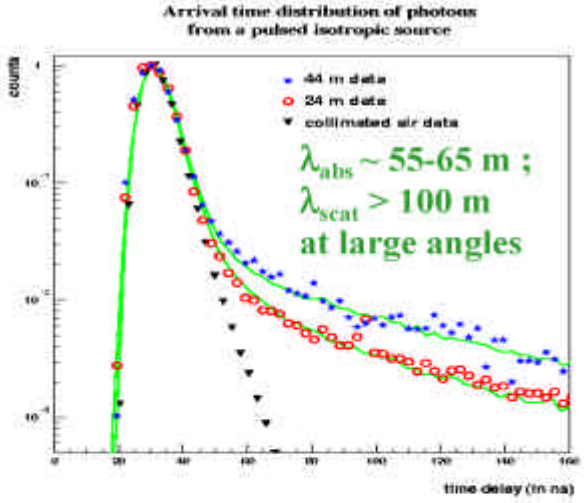
- Absorption lengths measured in Capo Passero are compatible with optically pure sea water data
- Large differences between Toulon and Capo Passero are observed in the blue region
- Values measured with the Antares Test 3' setup are in good agreement with the AC9 data
- The Toulon data are similar to those measured in the Catania Test Site (coastal waters)

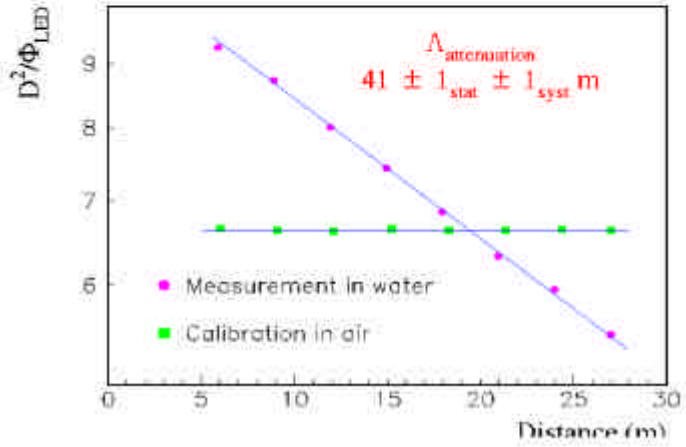




Water Transparency







Slide from P.Coyle talk

Group velocity also determined

Pylos data from NESTOR Collaboration

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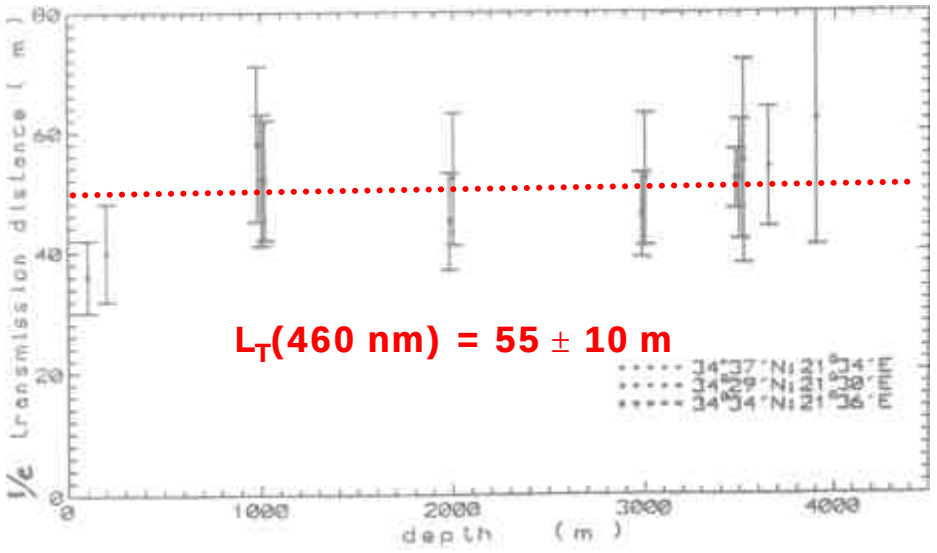


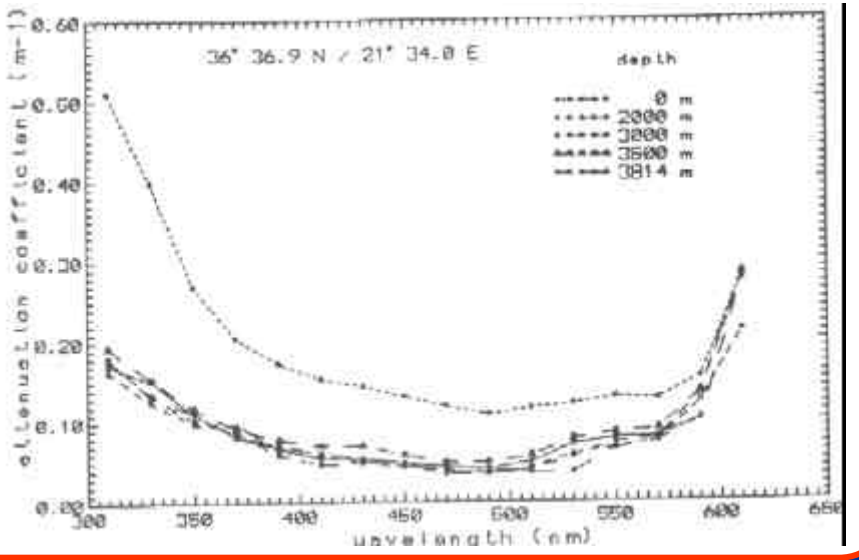
$L_T(460\ nm) = 55 \pm 10$ m

Transmission length

Measured in non-collimated geometry
(Annassontzis et al., NIM 1994)

Attenuation coefficient

Measured in collimated geometry using deep seawater samples
(Khanaev et al., NESTOR 1993)



NEMO: Oceanographic data measured in Capo Passero

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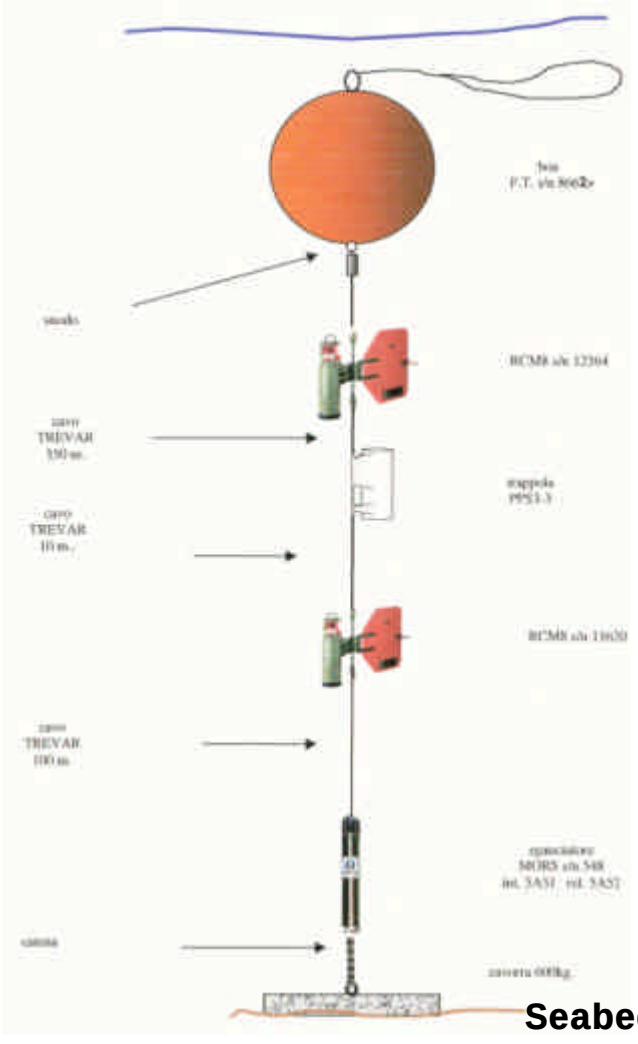

Two current metres and asediment trap are moored in Capo Passero Region since 1998.

Current metre 2900 m

Sediment trap 3000 m

Current meter 3050 m

The 2 current metres moored at different depths show the same behaviour

Seabed 3350 m

NEMO data: currents in Capo Passero

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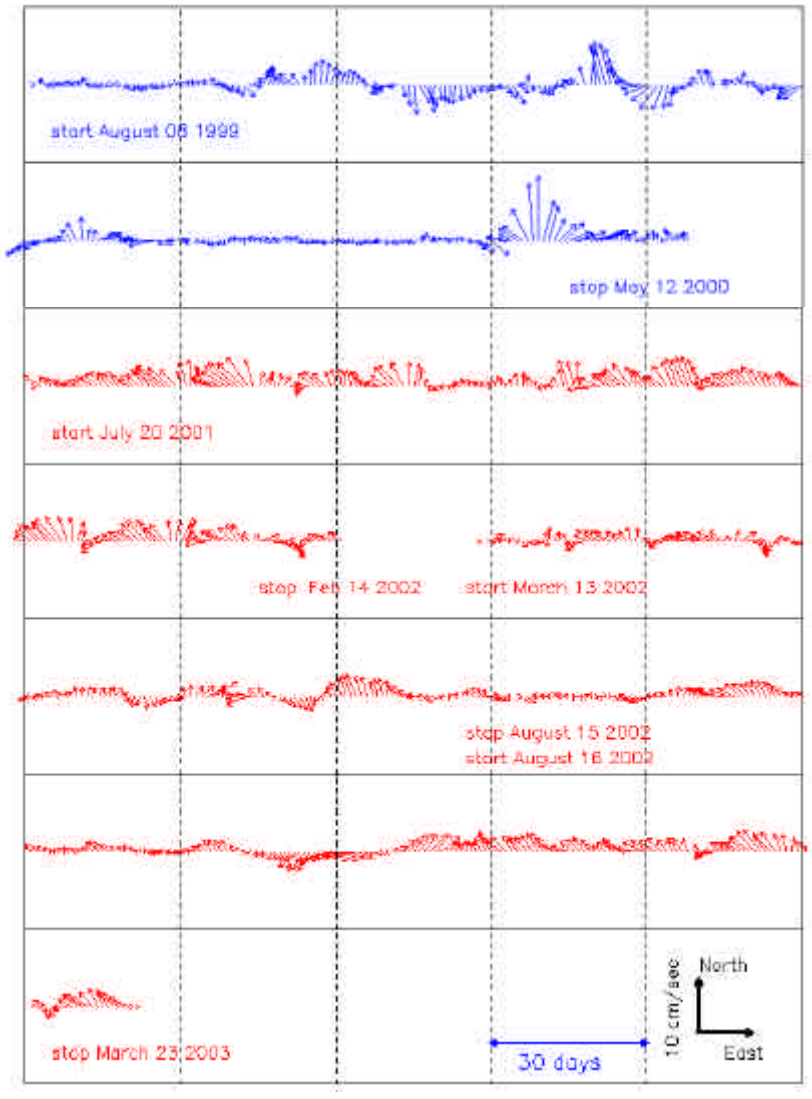
LNS-INFN



1999-2000
RCM8: Mechanical current meter

2001- Running
RCM11: Doppler current meter

Current metre at 3050 m depth

NEMO data: currents in Capo Passero

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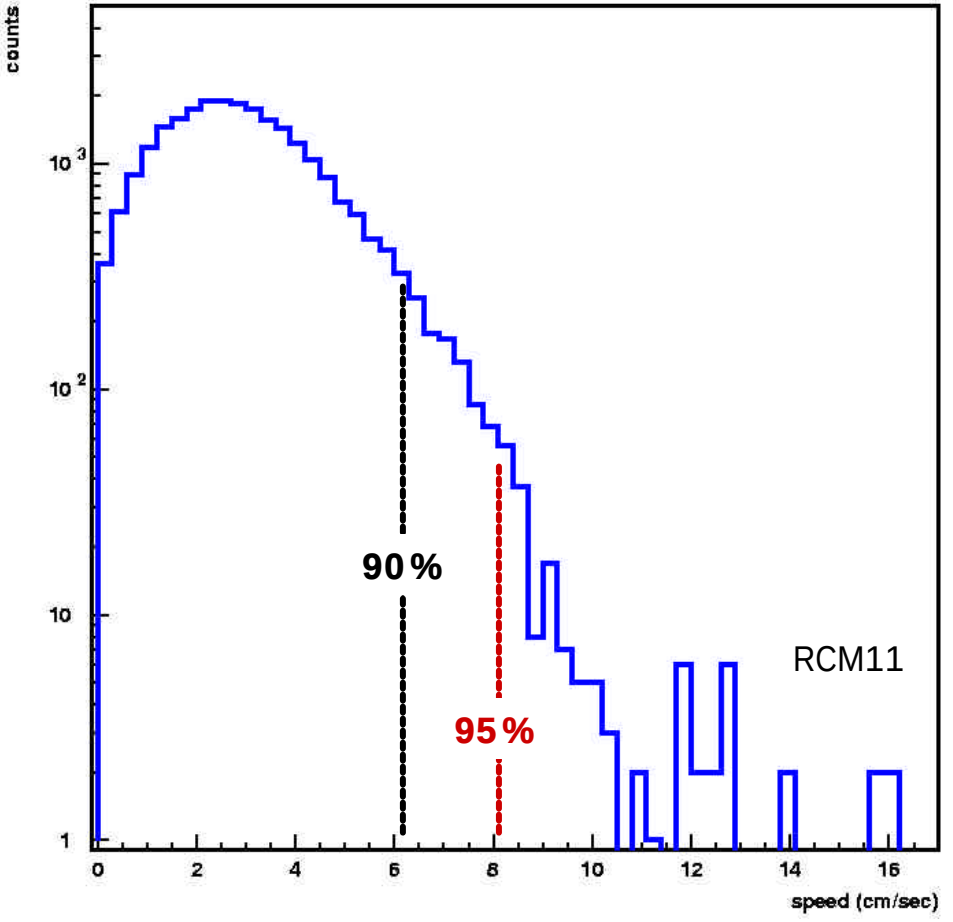
We have completed 3 full years of current data acquisition in Capo Passero KM4.
Results show an average current velocity of ~3 cm/sec (rms ~2 cm/s).
Maximum current intensity is never more than 16 cm/sec.



Current metre at 3050 m depth

Currents in Pylos: NESTOR data (short term)

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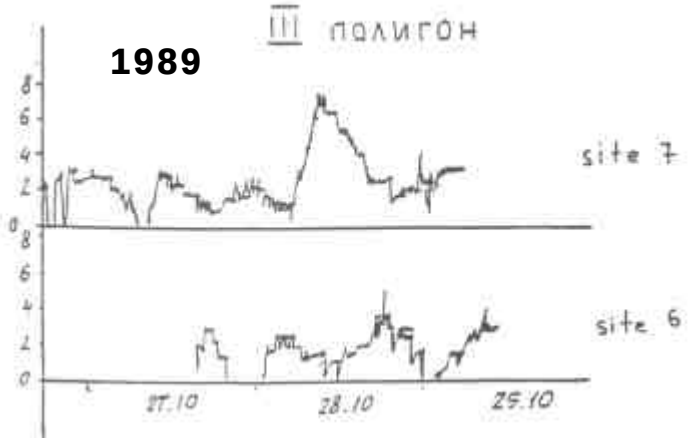

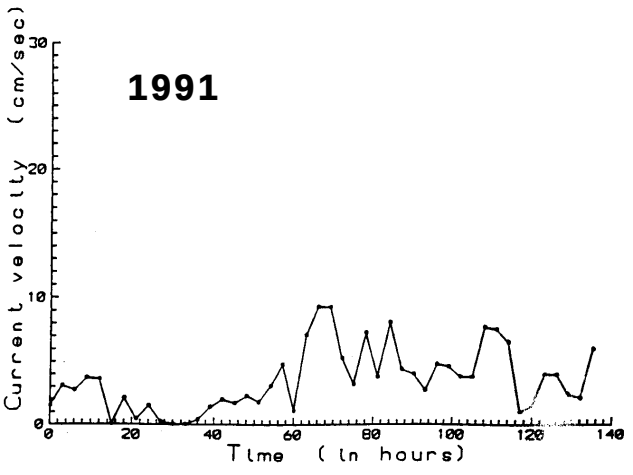

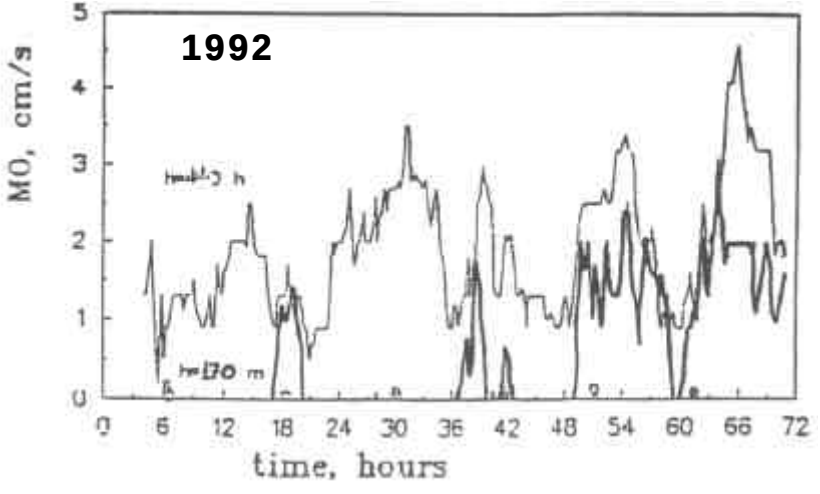

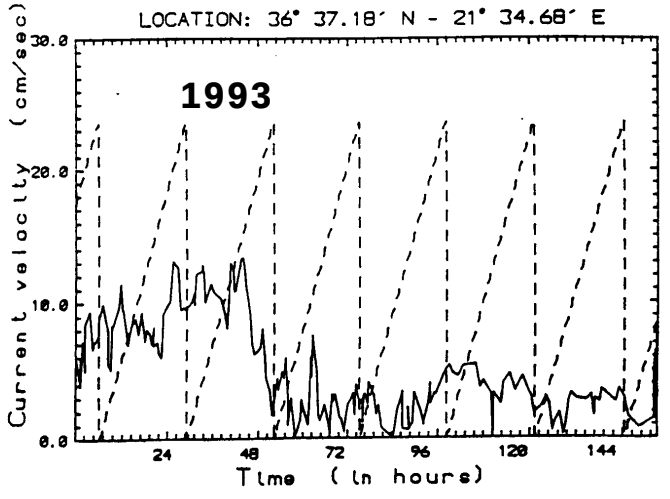

Sedimentation rate: Capo Passero and Toulon

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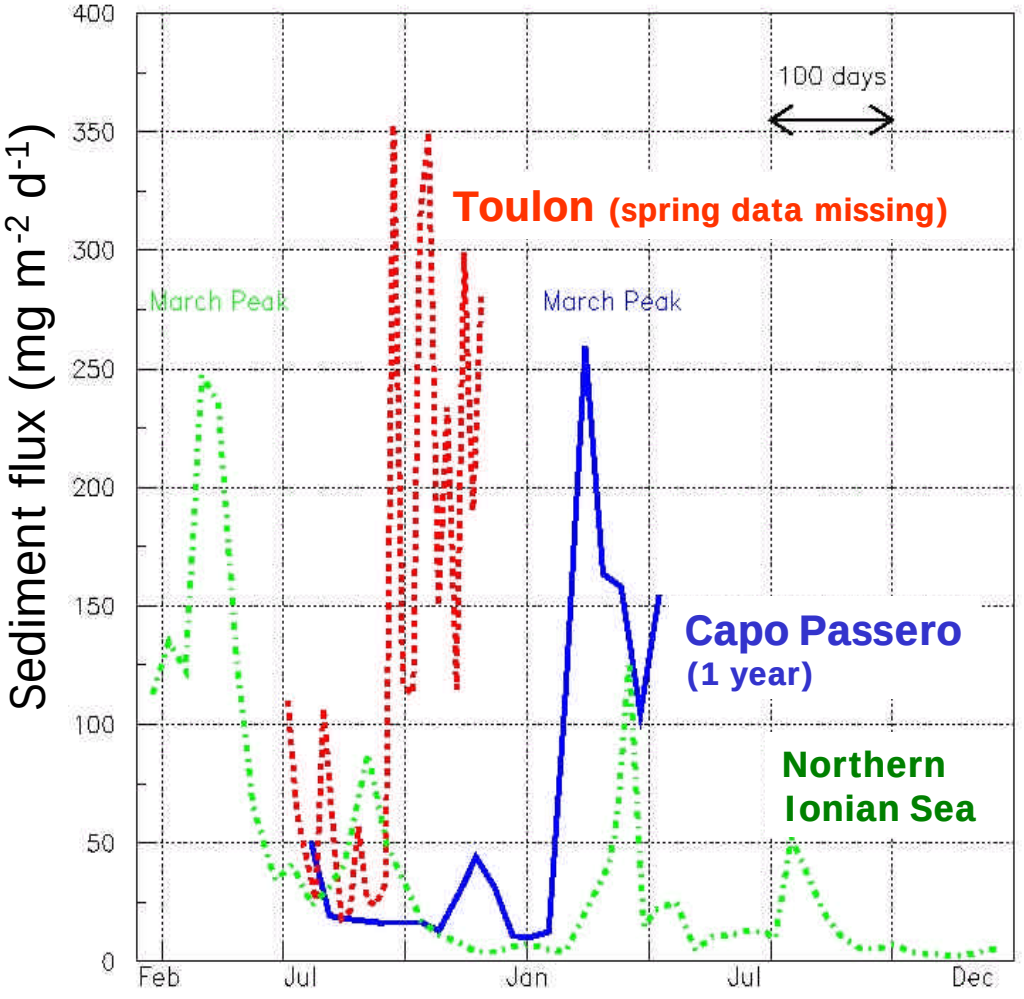

Two full years of data acquisition:
08 Aug 1999 30 May 2000 (analysed) 20 Jul 2002 15 Aug 2002 (under analysis)

Biofouling on optical surfaces

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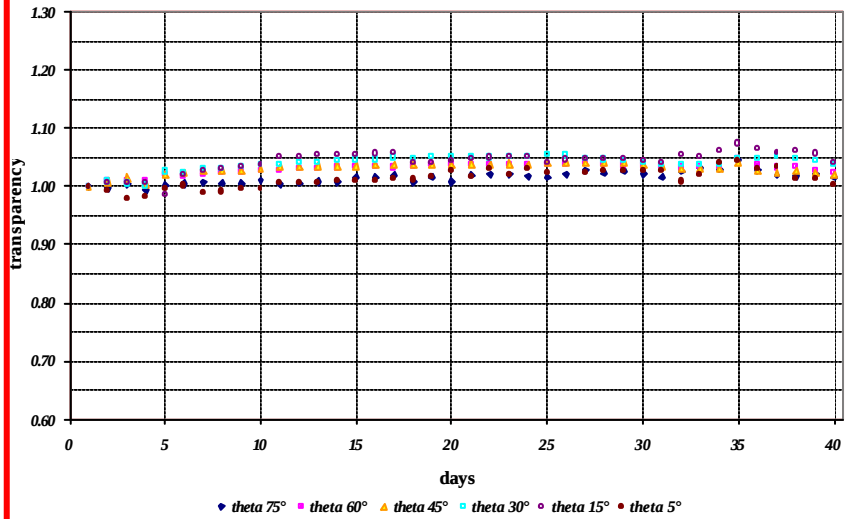
Capo Passero

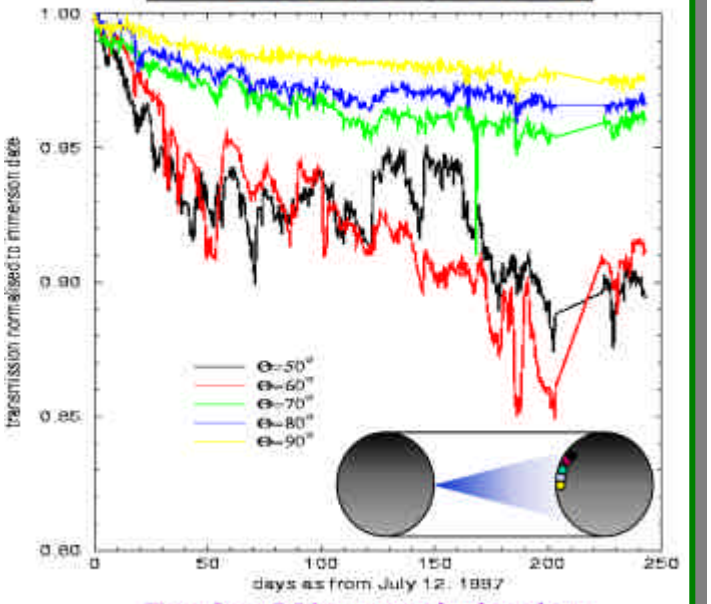
3200m depth



Transparency $=(PD/reference)_t / (PD/reference)_{day\#1}$

Negligible effect of fouling after 40 days

Toulon



For $\theta > 90°$ transmission loss
< 1.5% in 1 yr (and saturates)

Biofouling on optical surfaces

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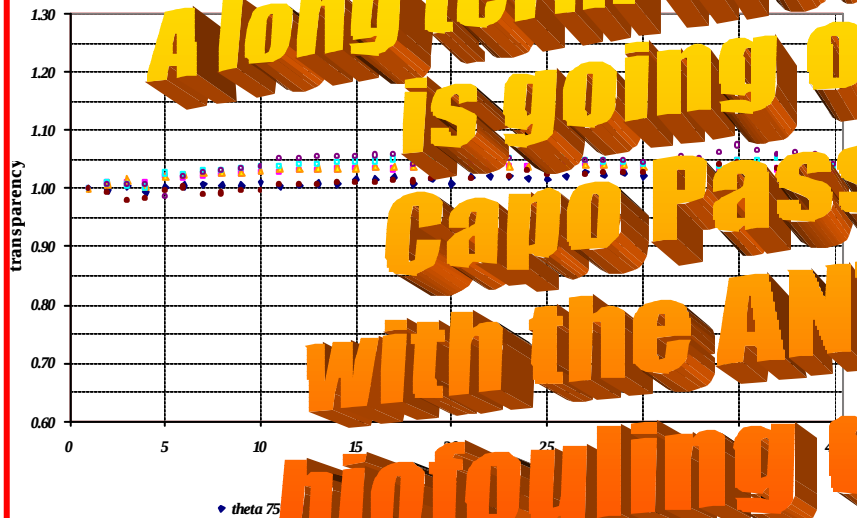
Capo Passero

3200m depth

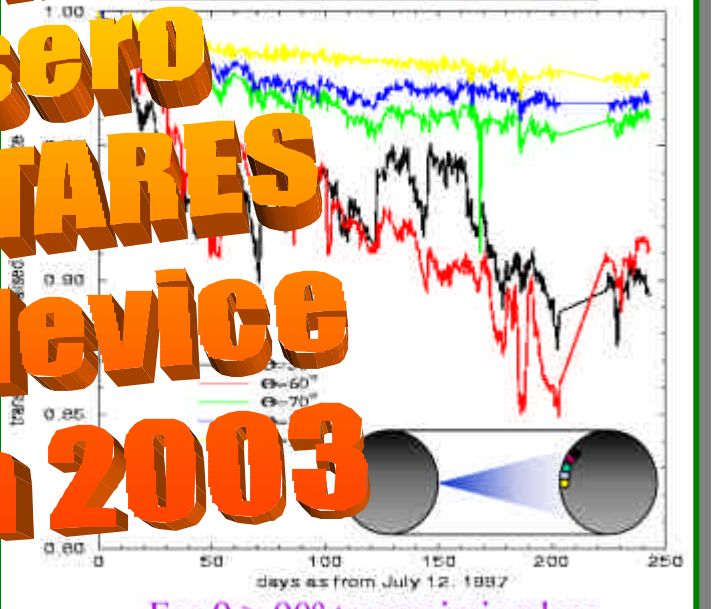


Transparency =(PD/reference), /

A long term measurement is going on in Capo Passero with the ANTARES biofouling device from March 2003

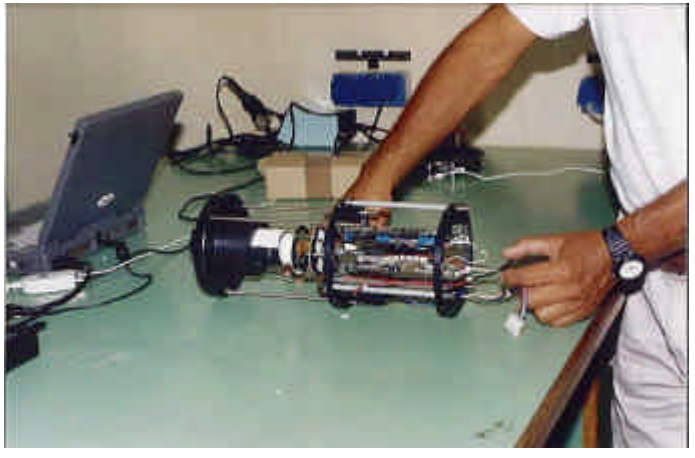
Negligible effect of fouling after 40 days

Toulon



For θ > 90° transmission loss < 1.5% in 1 yr (and saturates)

Masuremnets of Optical background



Profile of water column (2'' PMT)

Mooring line (3000m)

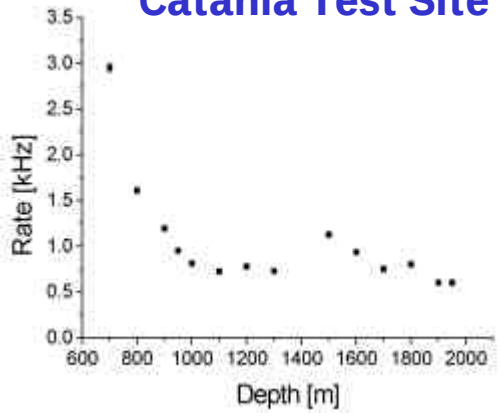
8'' PMTs

Optical background in Capo Passero and Catania

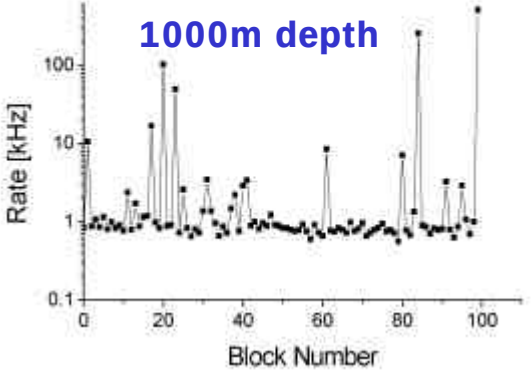
Rate measured with 2" PMT @0.25 s.p.e.

F.Massa, EPJ 2001

Catania Test Site

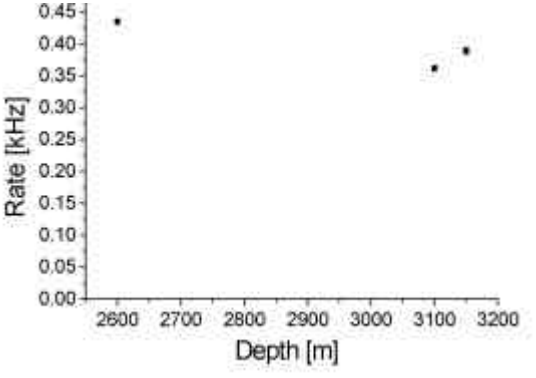


1000m depth

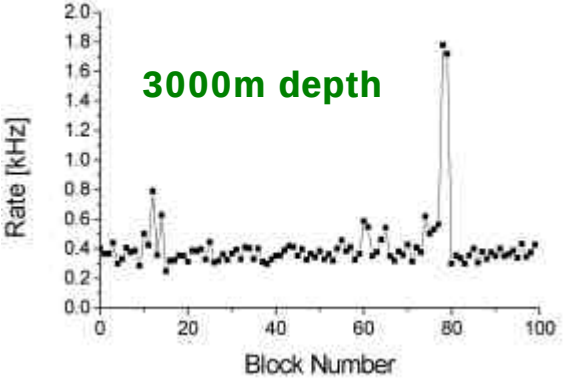


Rate(1000m) ~ 1000 Hz

Capo Passero



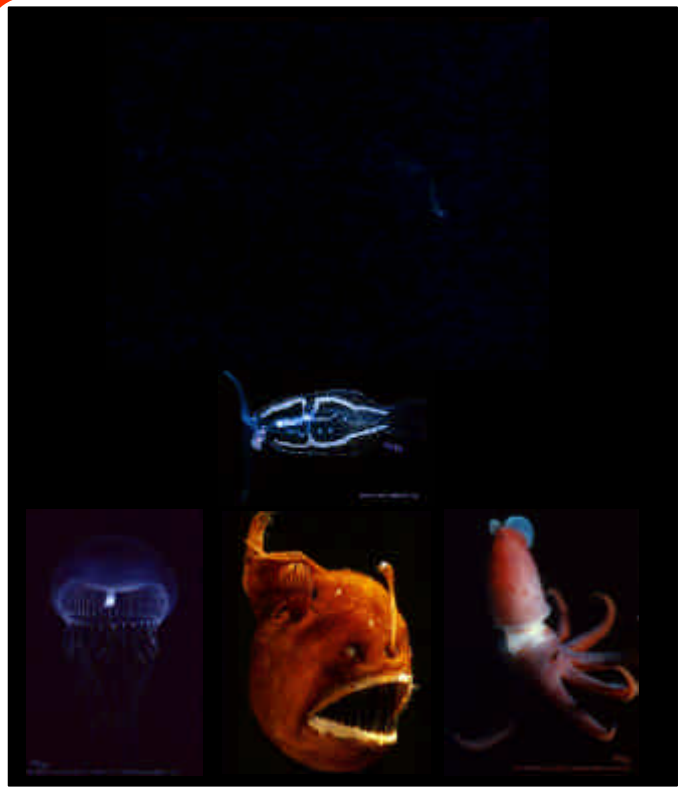
3000m depth

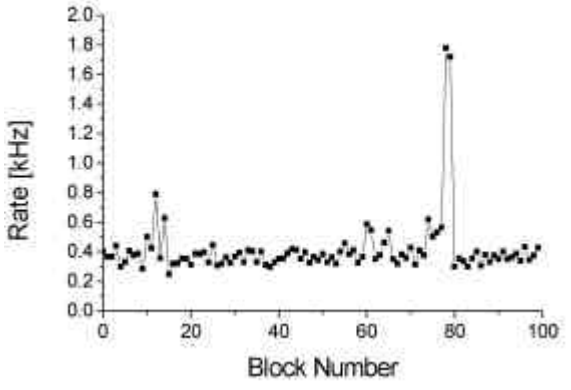


Rate(3000m) ~ 390 Hz

Bioluminescence in Capo Passero

G.Riccobene
LNS-INFN



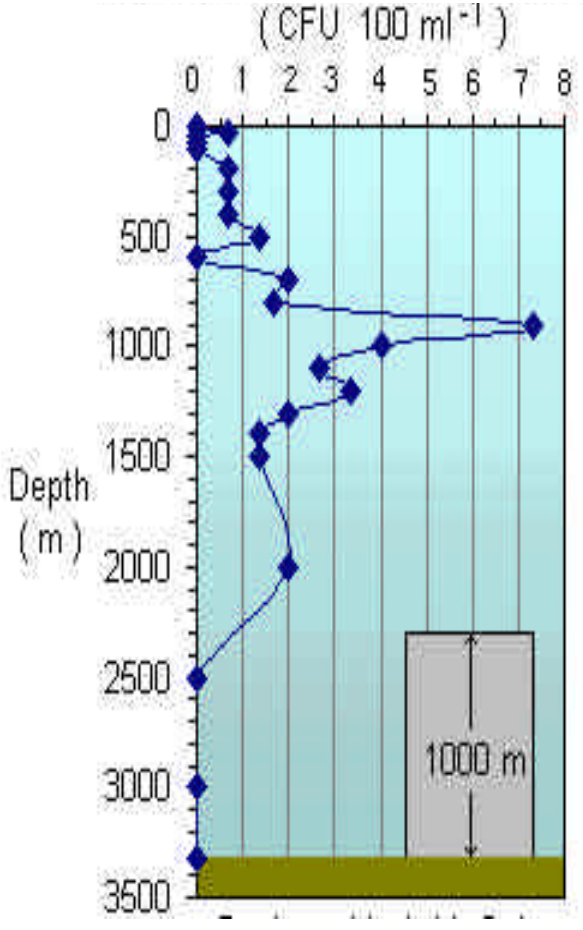


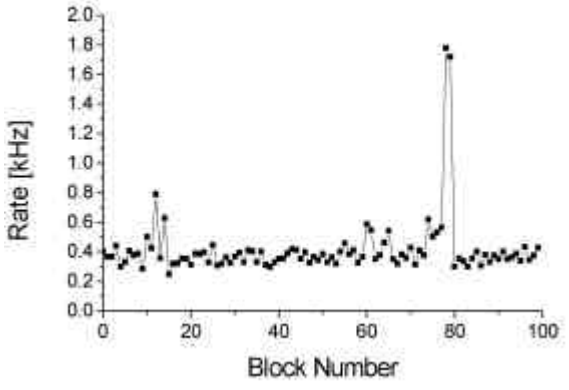
Optical noise rate in Capo Passero
Measured with 2'' PMT

Bioluminescence in Capo Passero

G.Riccobene
LNS-INFN

No luminescent bacteria have been observed in Capo Passero below 2500 m

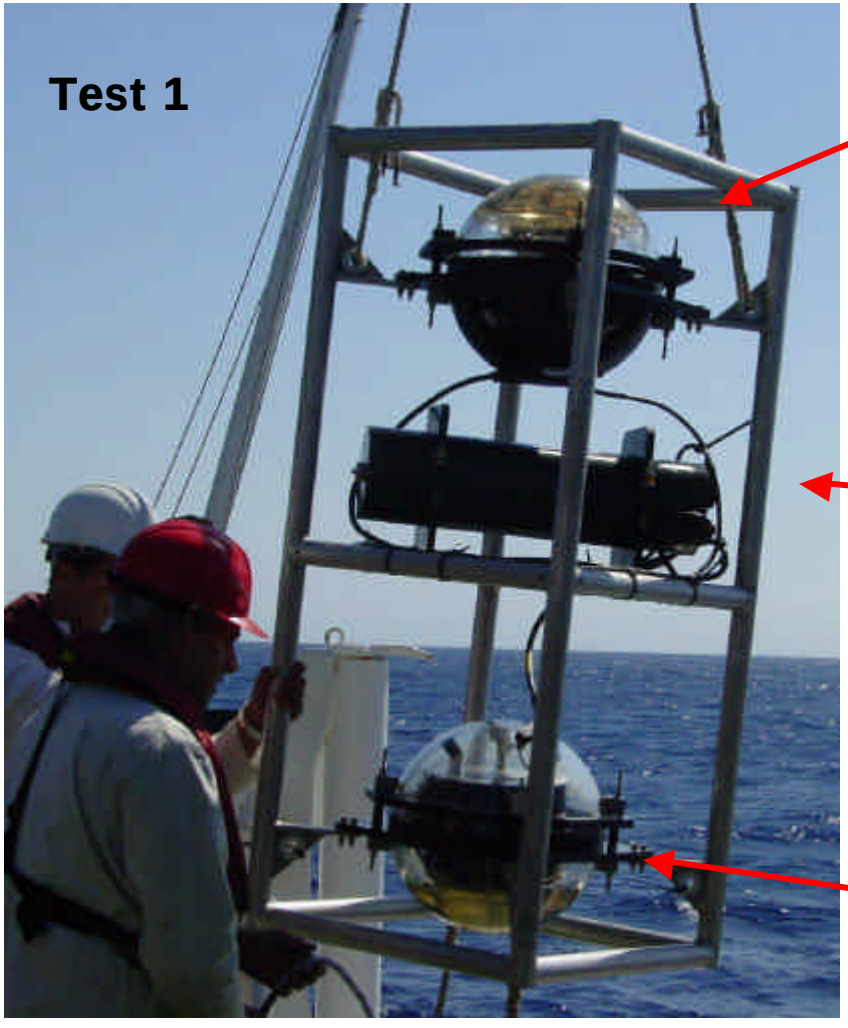




Optical noise rate in Capo Passero Measured with 2'' PMT

Joint Sea Campaign ANTARES -NEMO: bioluminescence

G.Riccobene
LNS-INFN



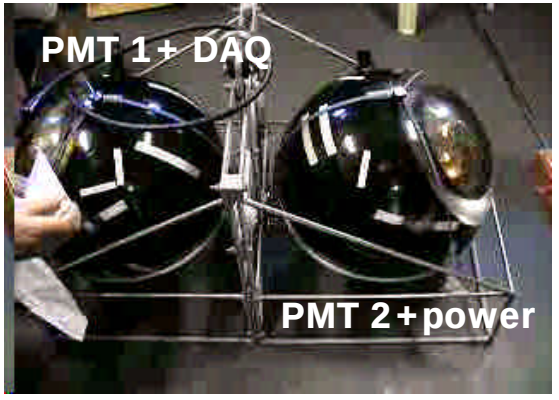
Detector: PMT
(10” Hamamatsu)

CPU and
memory (160Mb)

Energy (> 350 h)

Optical background in Capo Passero and Toulon

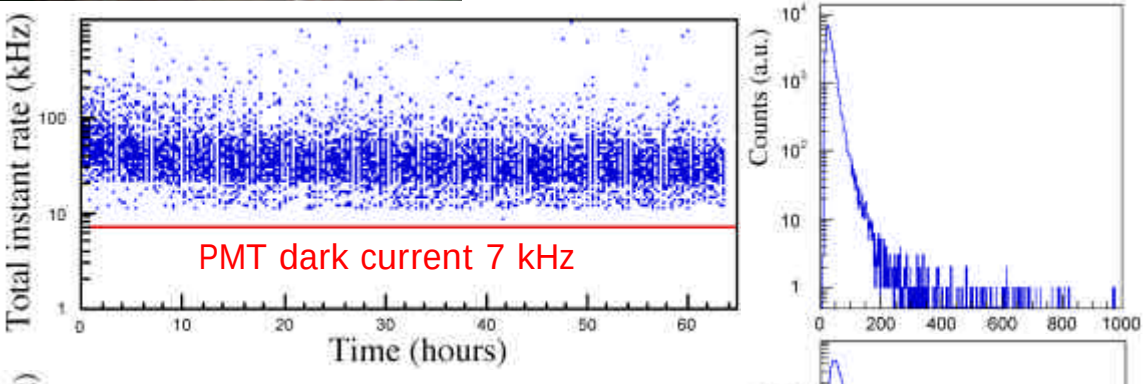
G.Riccobene
LNS-INFN



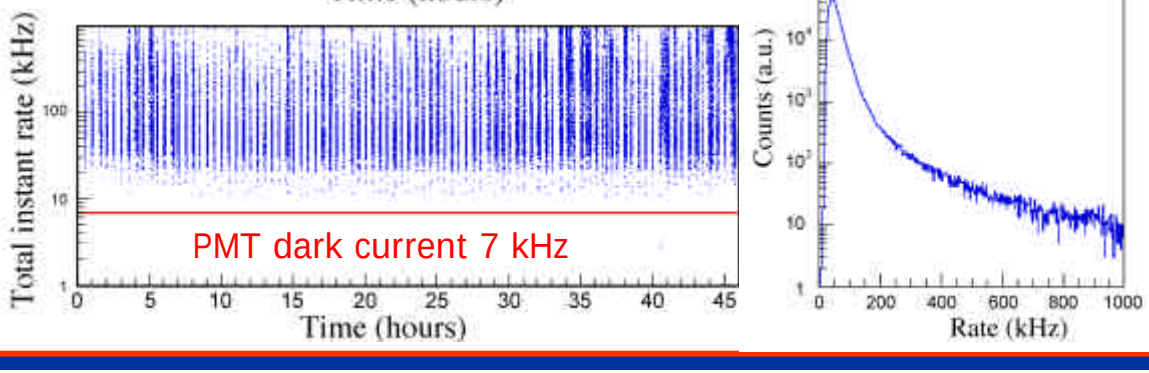
NEMO device (8" PMT at 0.3 spe)

- Toulon 58.0±3.0 kHz
- Capo P. 28.5±2.5 kHz

Capo Passero

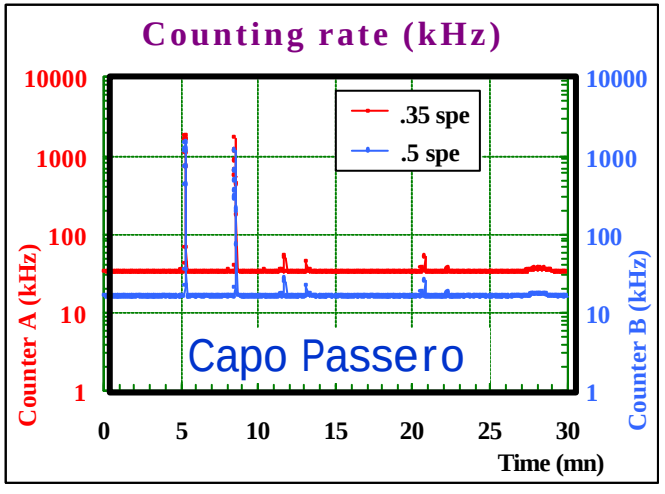


Toulon



Optical background in Capo Passero and Toulon

G.Riccobene
LNS-INFN



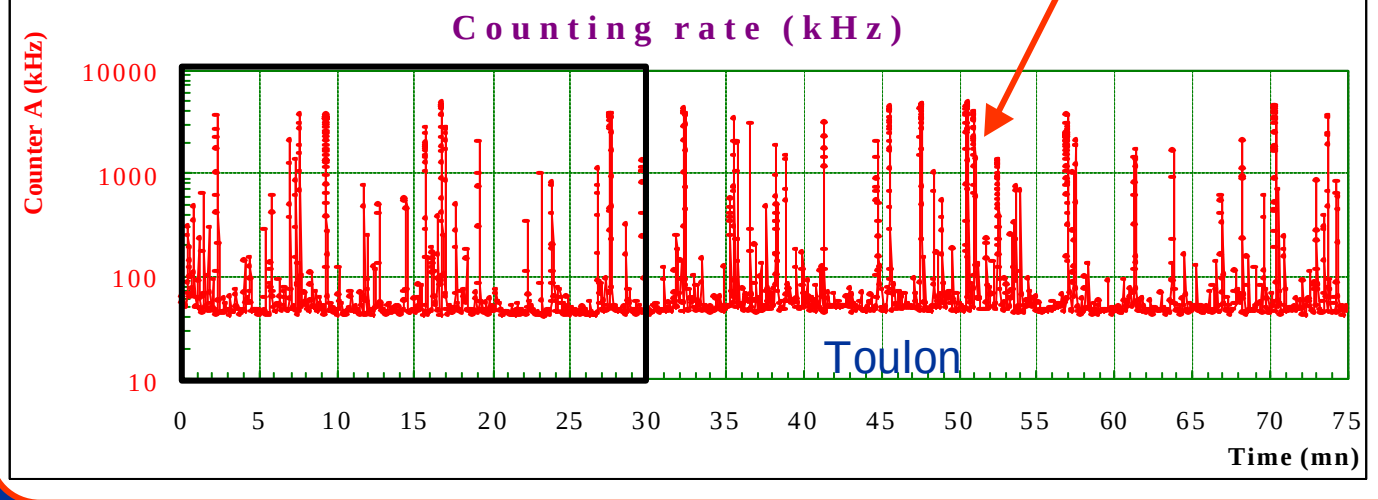
Test 1 data

Courtesy of J.P. Schuller

ANTARES device (10'' PMT at 0.5 spe)

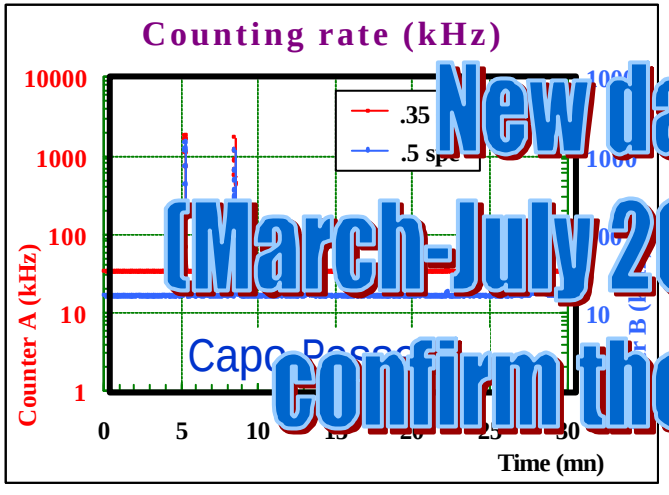
- **Toulon 44 kHz**
- **Capo P. 15 kHz**

Bioluminescence bursts



Optical background in Capo Passero and Toulon

G.Riccobene
LNS-INFN



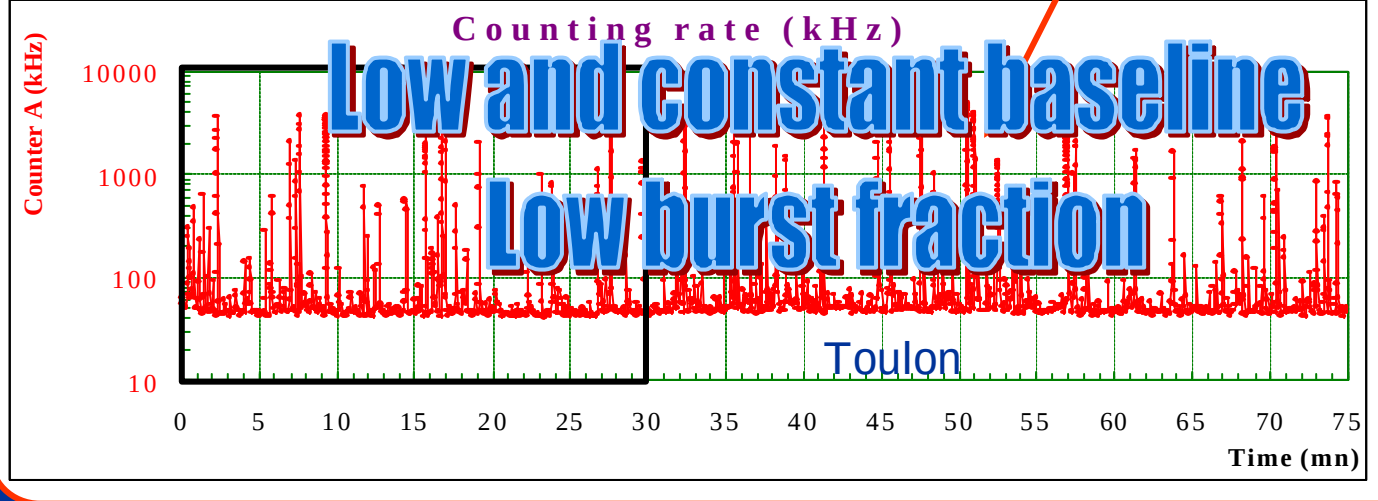
Test 1 data

J. Schuller

New data from Test 1 (March-July 2003) in Capo Passero confirm the previous results !

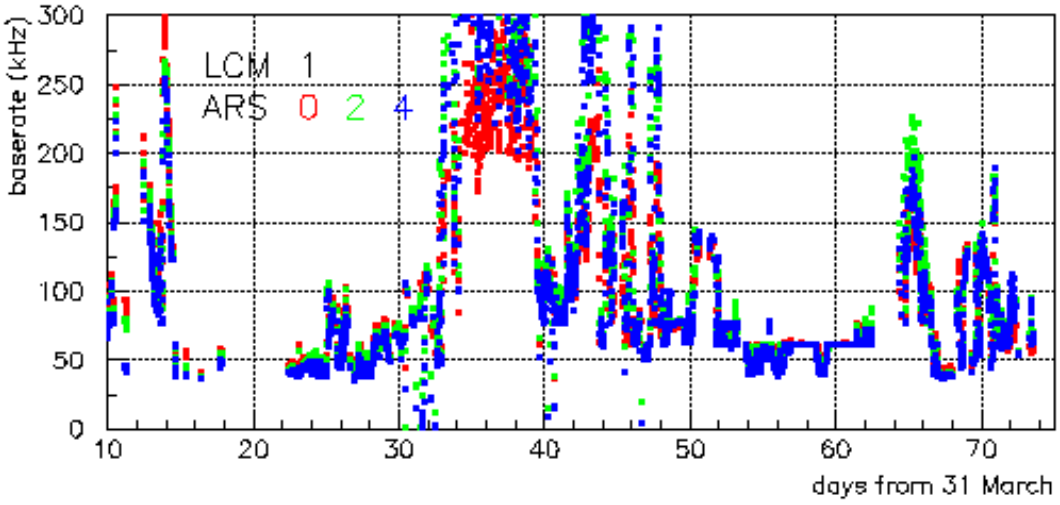
- Capo P. 15 kHz

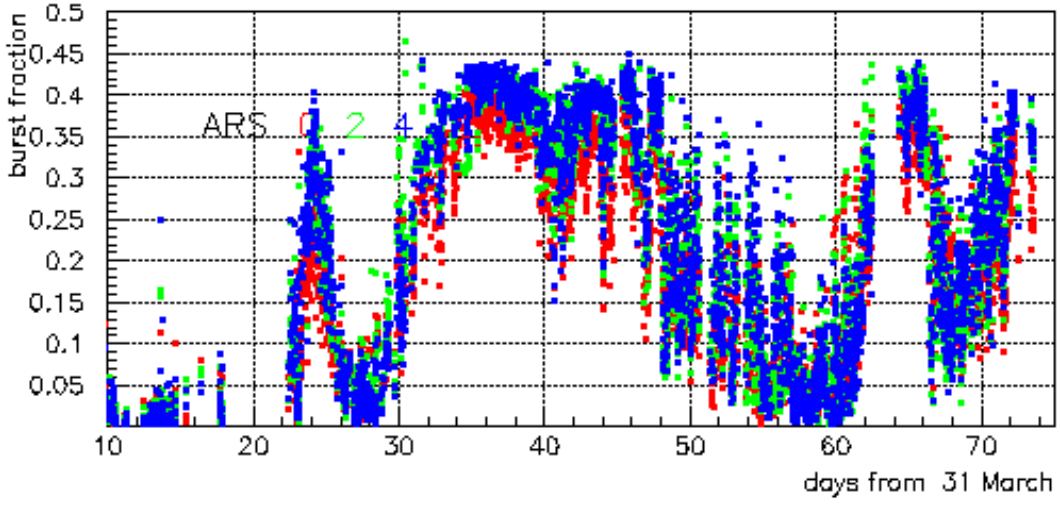
Bioluminescence bursts



Optical background in Toulon: ANTARES data

G.Riccobene
LNS-INFN





Bioluminescence and sea-currents

G.Riccobene
LNS-INFN

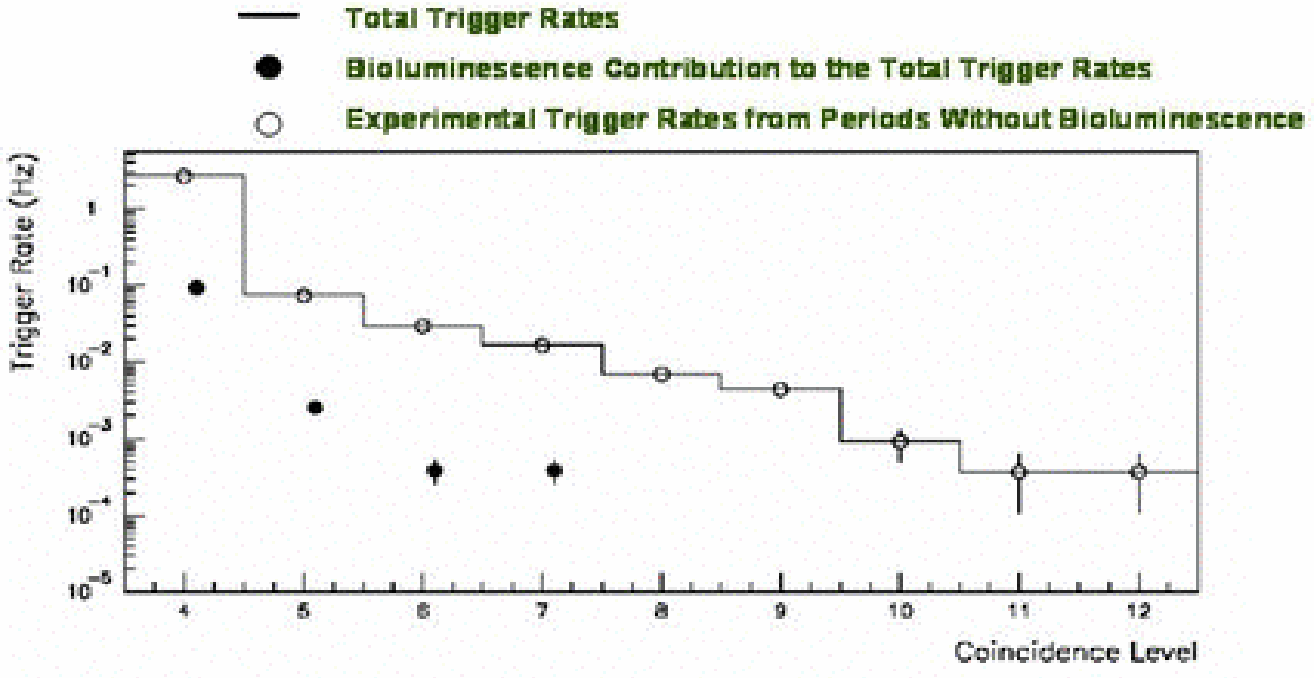
a “gold fish bag” containing dinoflagellates...
...shaked

Optical background in Pylos: NESTOR data

Data from a depth of 4000 m

Bioluminescence Contribution to the Total Trigger Rates

Bioluminescence Occurs for the 1.1% ± 0.1% of the Active Experimental Time



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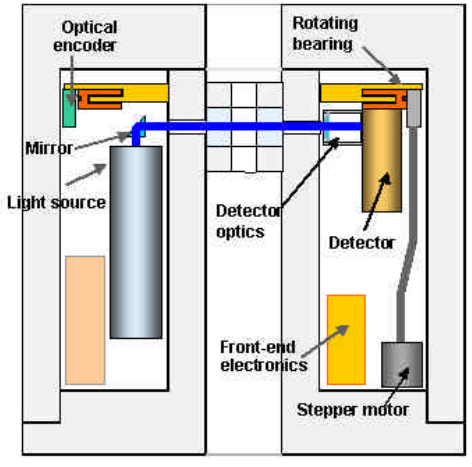
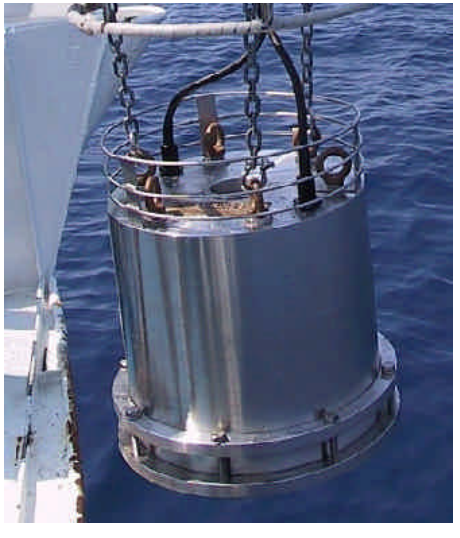
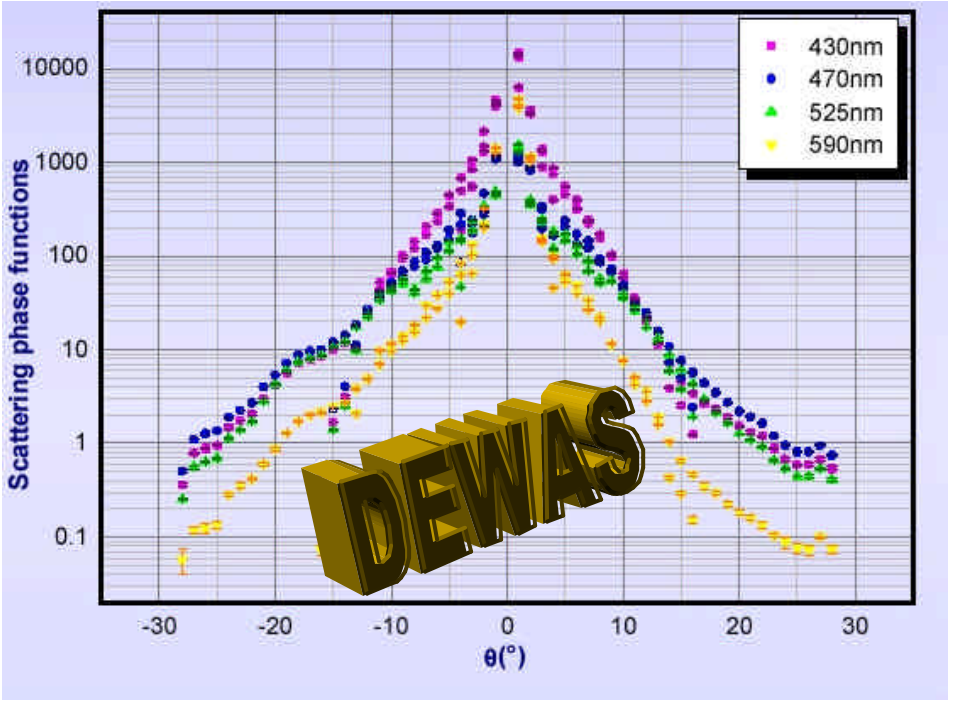




Measurement of the volume scattering function (scattering anular distribution) is a very important input for Montecarlo



Presently a new configuration is under test In order to enhance the performances

Water “acoustic” properties

G.Riccobene
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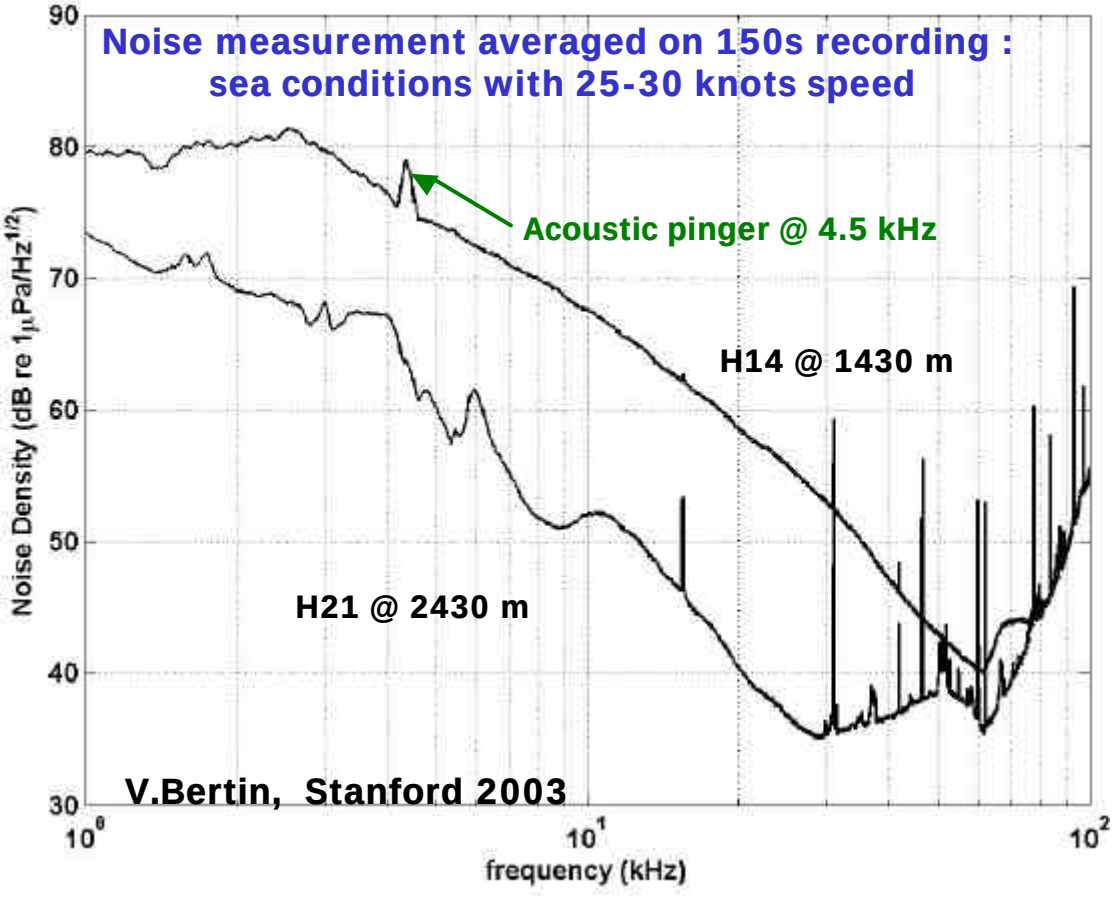
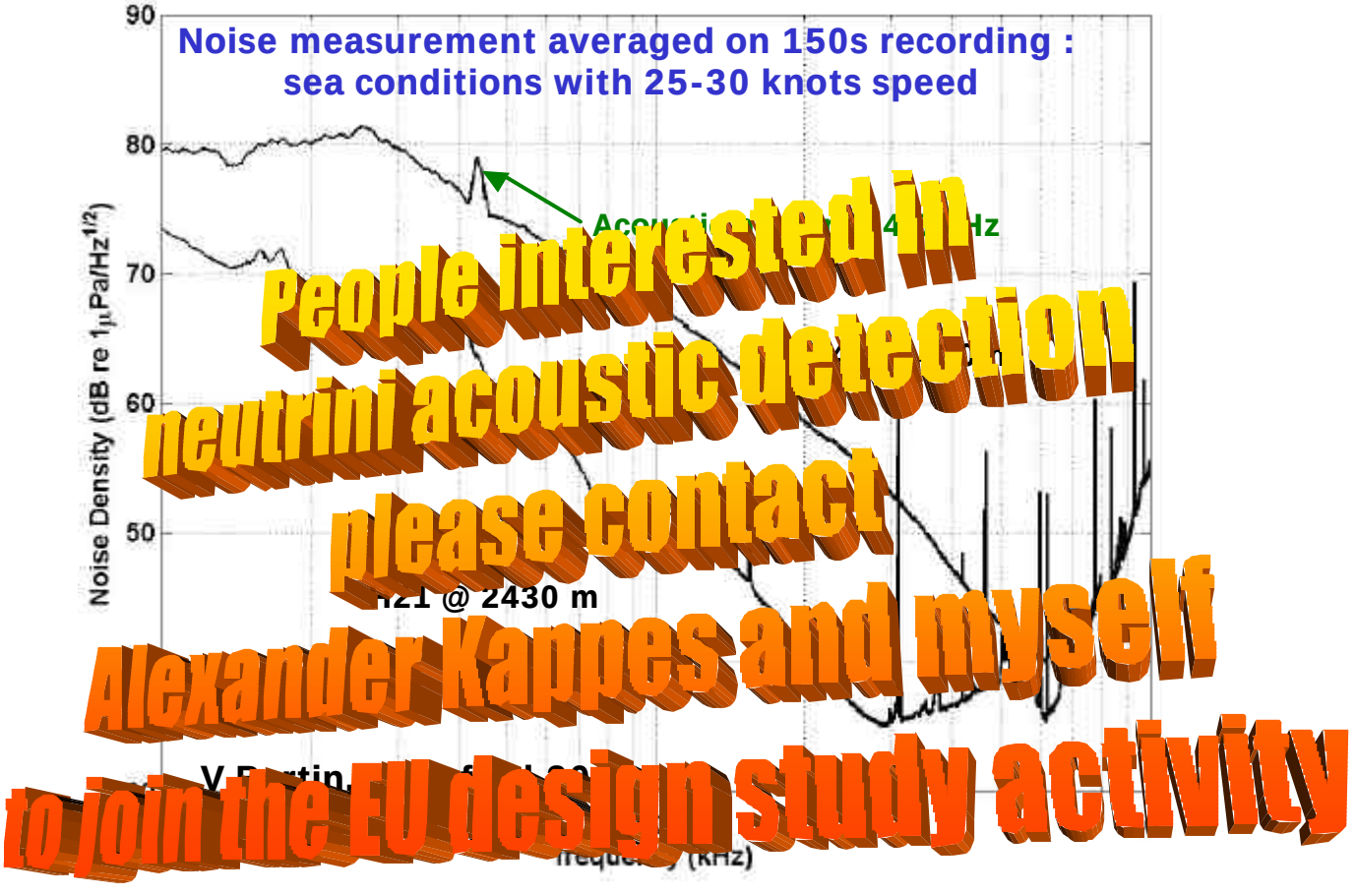


Also NESTOR data in Pylos (Butkevich, 1995)

Water "acoustic" properties



Also NESTOR data in Pylos (Butkevich, 1995)

Conclusions

G.Riccobene
LNS-INFN

- **Long term characterization of water properties is mandatory for**

selection of the km^3 installation site

km^3 detector design

right input for montecarlo and data analysis

...variability (absorption, scattering, optical noise)

Conclusions

The town of Porto Palo di Capo Passero

Data measured over 5 years show that Capo Passero is an optimal site for the installation of the km^3 detector:

Light optical properties are close to optically pure water one and are stable
Optical noise is compatible with very low bioluminescent activity
The site is located in an oligotrophic region (Ionian Plateau)