



Autonomous Instruments in Oceanography

- Yuri Controneo

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Mission 4 “Education and Research” - Component 2: “From research to business” - Investment
3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures”





Autonomous Instruments in Oceanography

10-14 February 2025

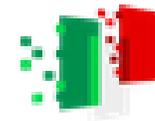
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Autonomous Instruments in Oceanography

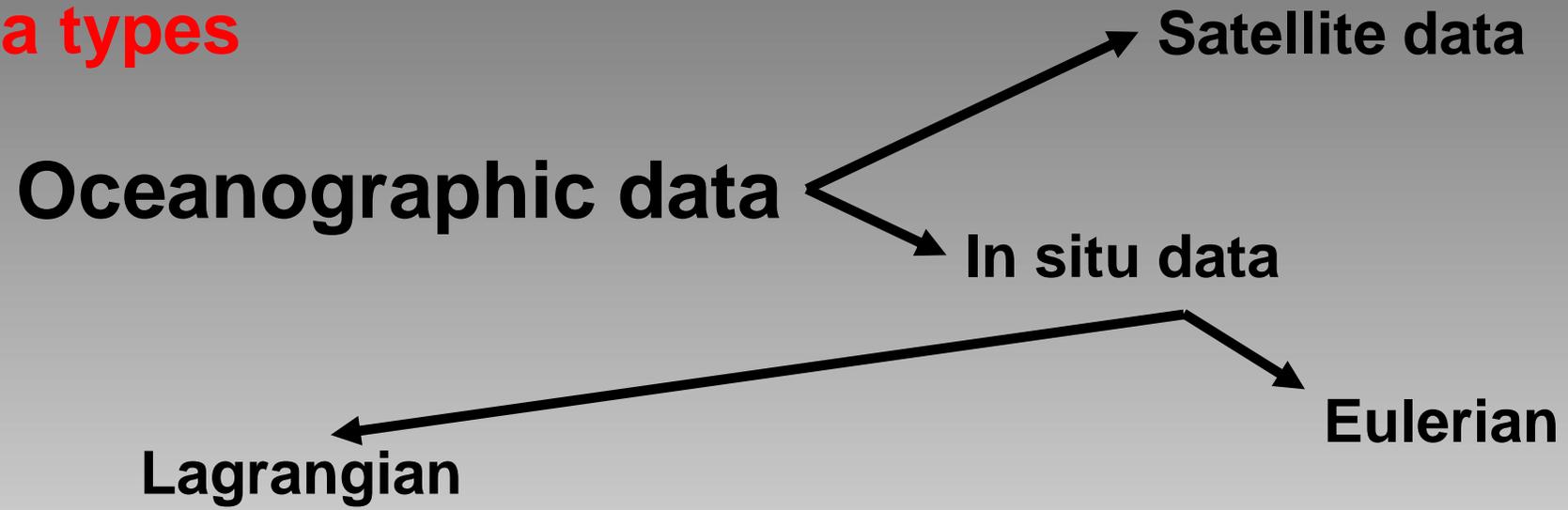
- Drifters
- Argo Floats
- **XBTs**
- Gliders

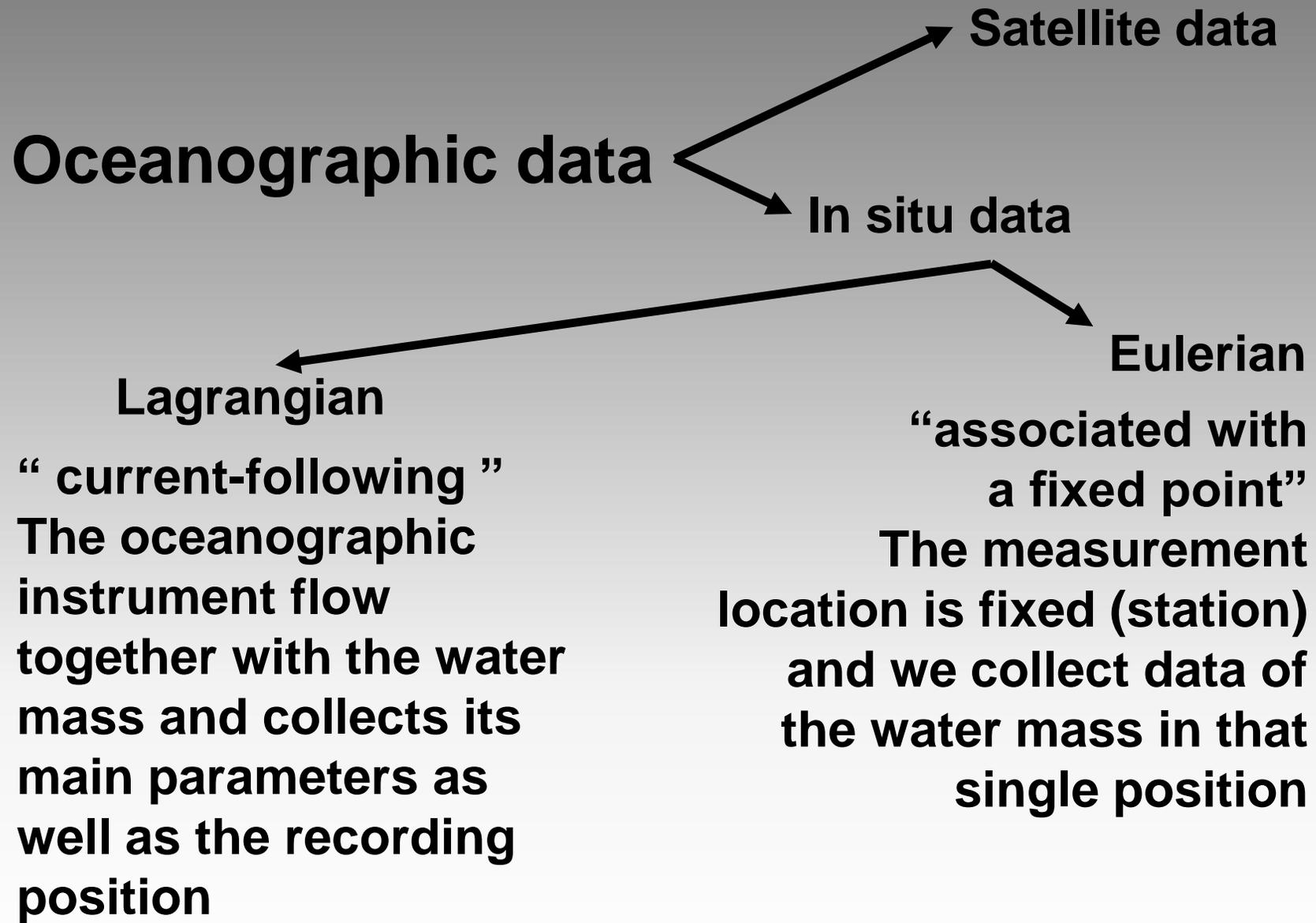


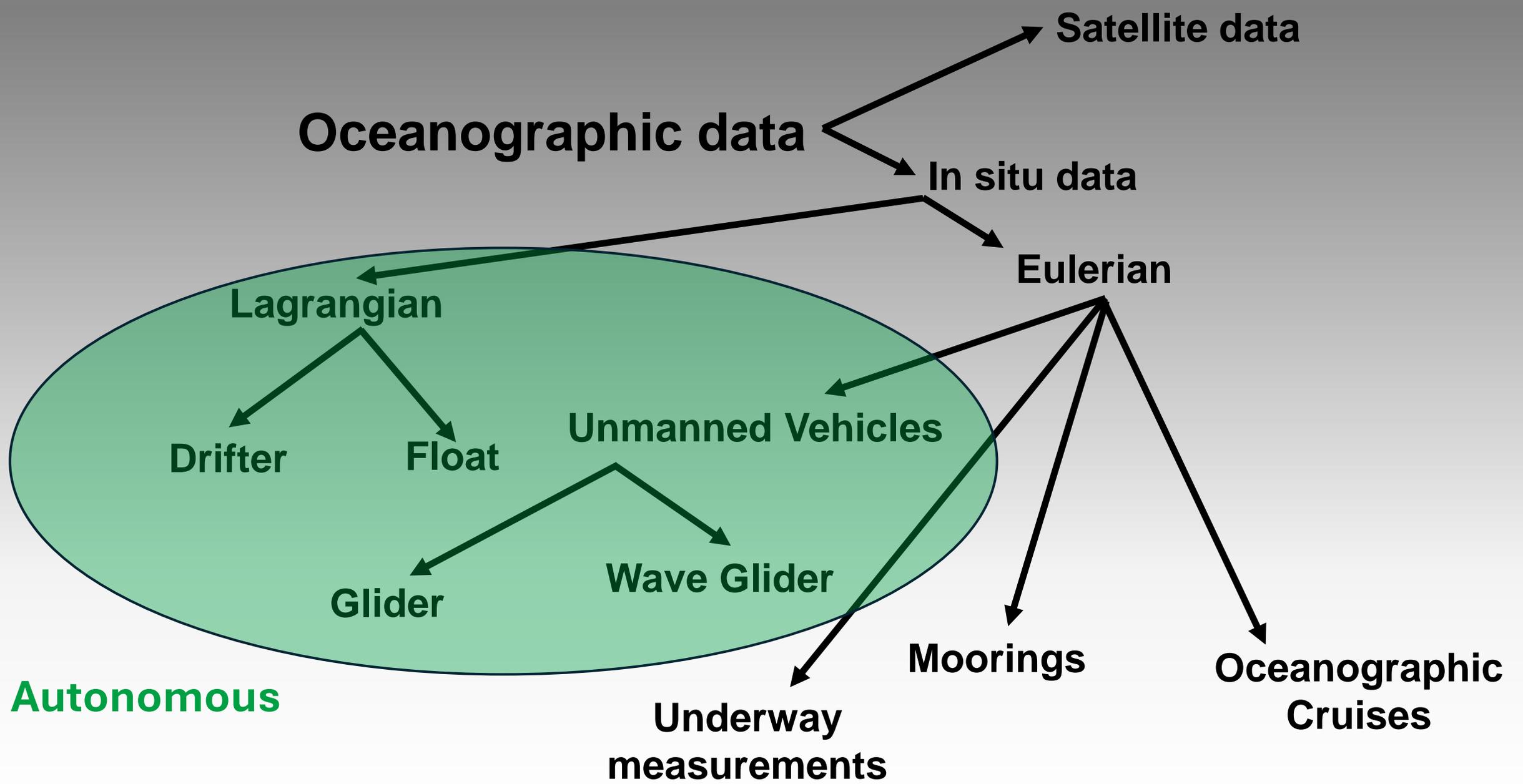
**Are XBTs autonomous?
What they measure?
How?
Why are they in this list?**



Data types







Autonomous Instruments in Oceanography

- **Drifters**
- **Argo Floats**
- **XBTs**
- **Gliders**

Autonomous instruments are strictly dependant on classical oceanographic data in some phases of their lives.

Additionally some instruments like the XBTs can be viewed as a first step toward an autonomy from scientific personnel and research vessels



But «classical» oceanographic data collection is not so easy.....

- Ship based measurements are difficult and expensive
- Coupling of measurements to a well defined depth
- Spatial and temporal resolution issues



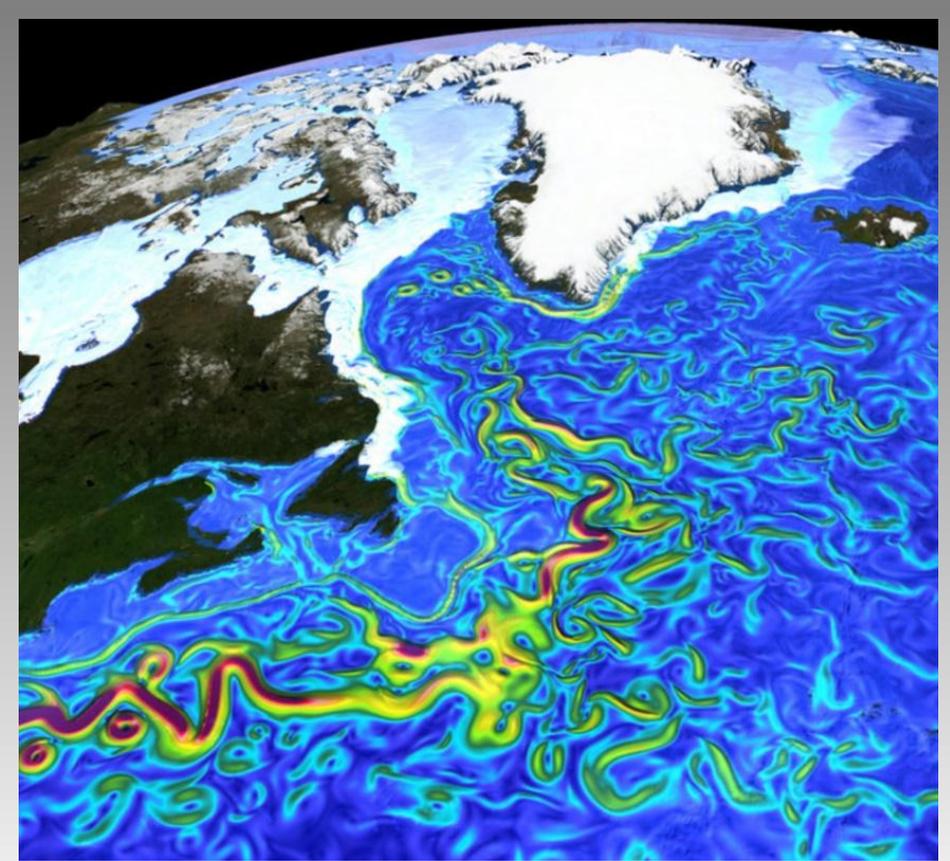
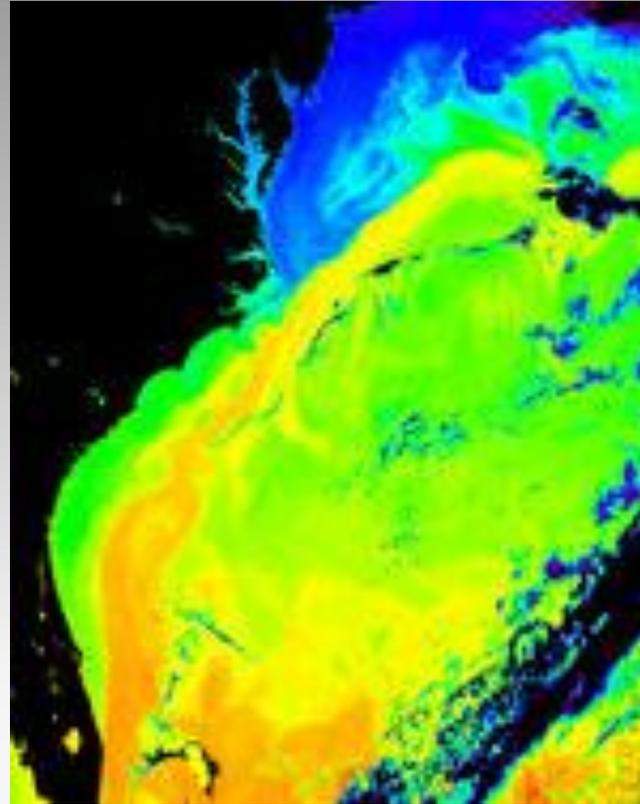
Large scale measurements of water properties started in 1873 since then, we had a lot of mission....

but the ocean is still unexplored

Lack of measurements has been interpreted as lack of dynamics or variability.

Now with high resolution observations we know that more and more spatial and temporal scales exist.





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- Ocean observation is expensive→ need to accurately plan the field work.
- Planning the observations is crucial, as a wrong planning leads to wrong conclusions or unuseful data.
- First of all we must focus on what we would like to observe and which are observation constraints:

Spatial and temporal resolution,

Depth,

Parameters.....



Main oceanographic observations

- WATER MASS PROPERTIES

- Temperature,
- Salinity
- Pressure

- WATER MASS DYNAMICS

- Sea current along three directions
- wave motion
- tides



Since 1969 physical parameters along the water column are usually monitored through a CTD probe.

C stands fo Conductivity

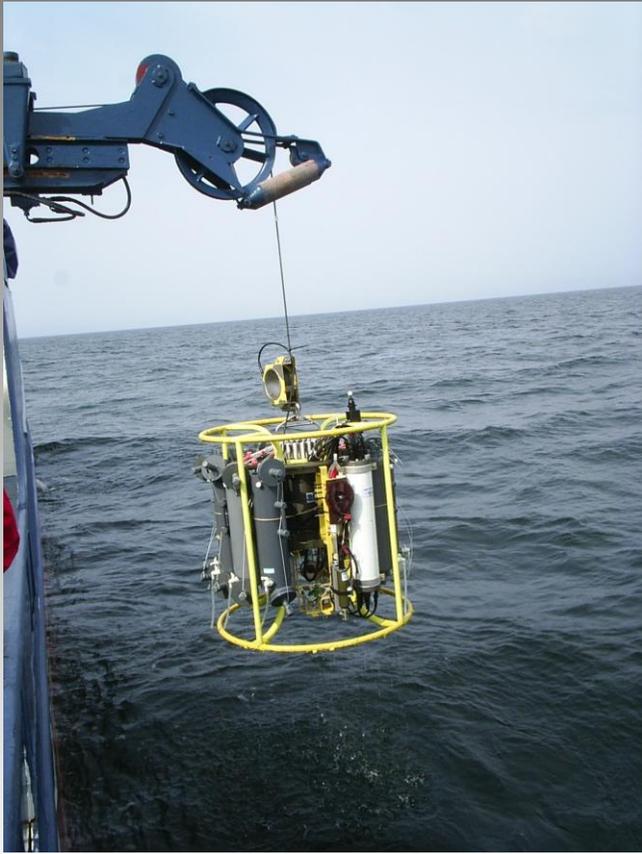
T for Temperature

D for Depth



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Measurements of physical parameters along the water column



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Parametri Oceanografici misurati e calcolati

WHAT IS DIRECTLY MEASURED:

-temperatura, Conductivity, Pressure,
Oxygen concentration, Fluorescence, Turbidity...

What is then estimated

- Depth as a function of Pressure and latitude
- Salinity as a function of C,T and P
- Density as a function of T, S and P
- Sound Velocity as a function of T, S and P



CTDs and all the profiling systems

- **Internal memory**

data are stored and can only be read at the retrieval

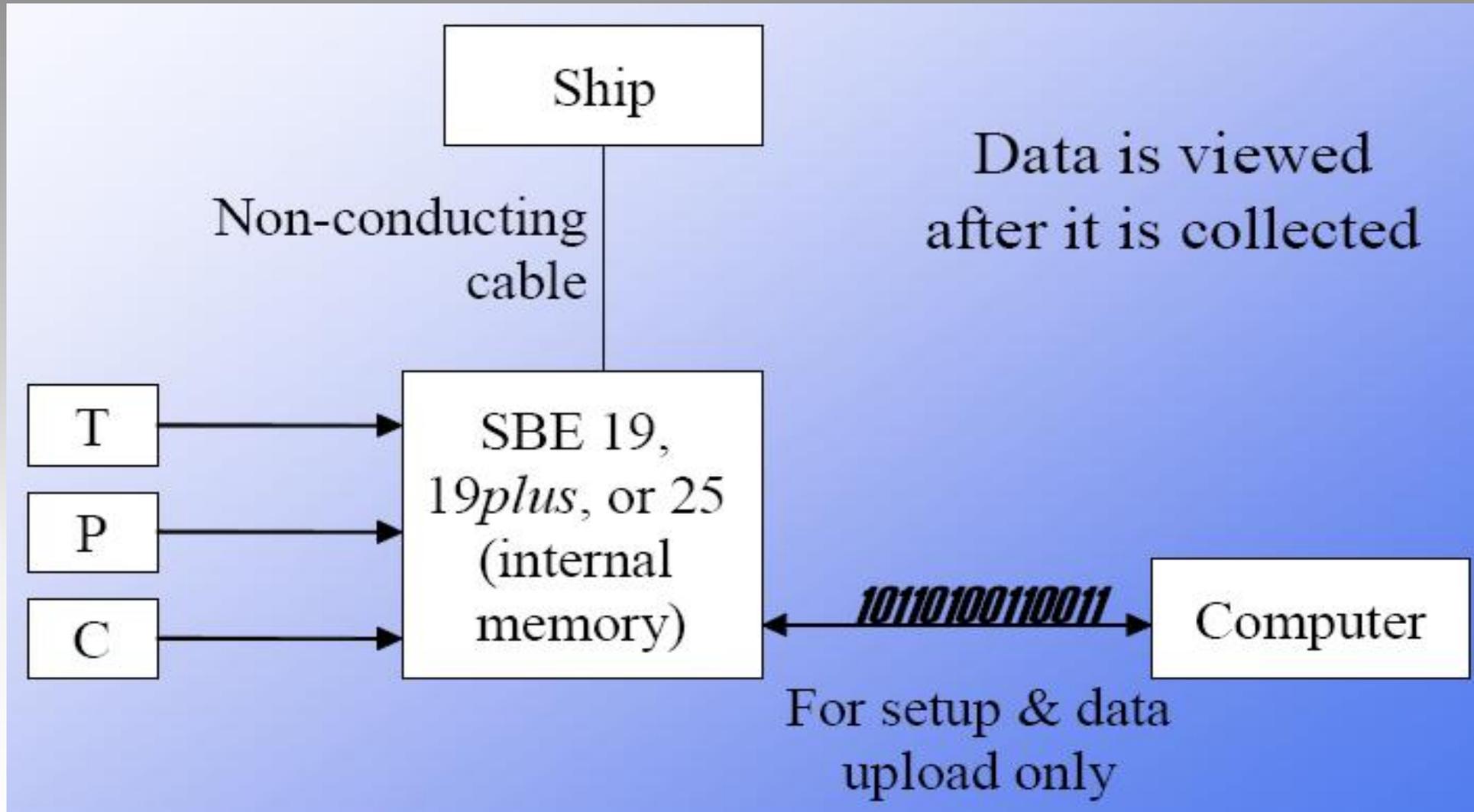
- **real-time transmission**

data are transmitted live onboard through a connection cable

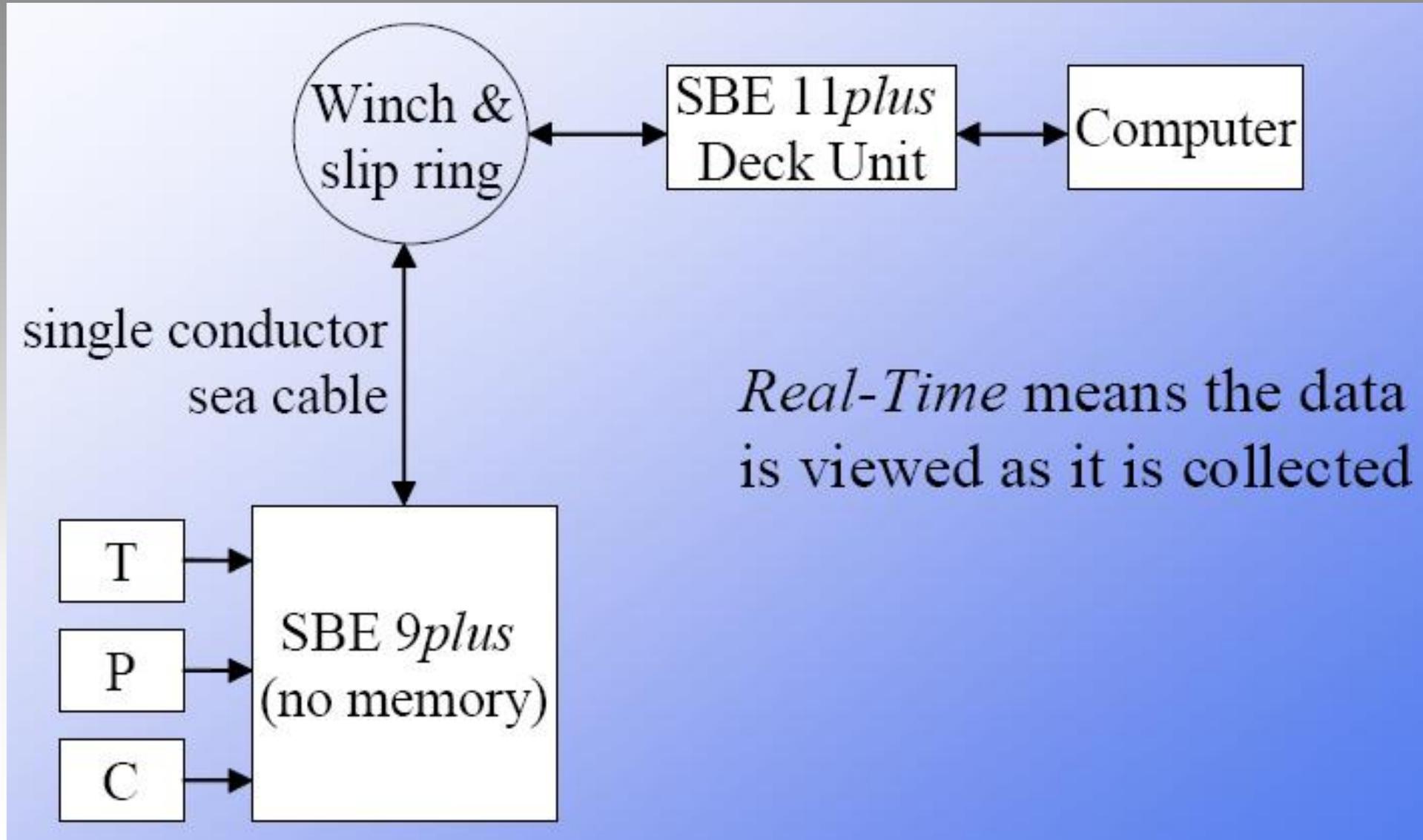
real-time CTD can be equipped with a oceanographic bottles to be closed remotely (some exception with ECO-Sampler & Co.)

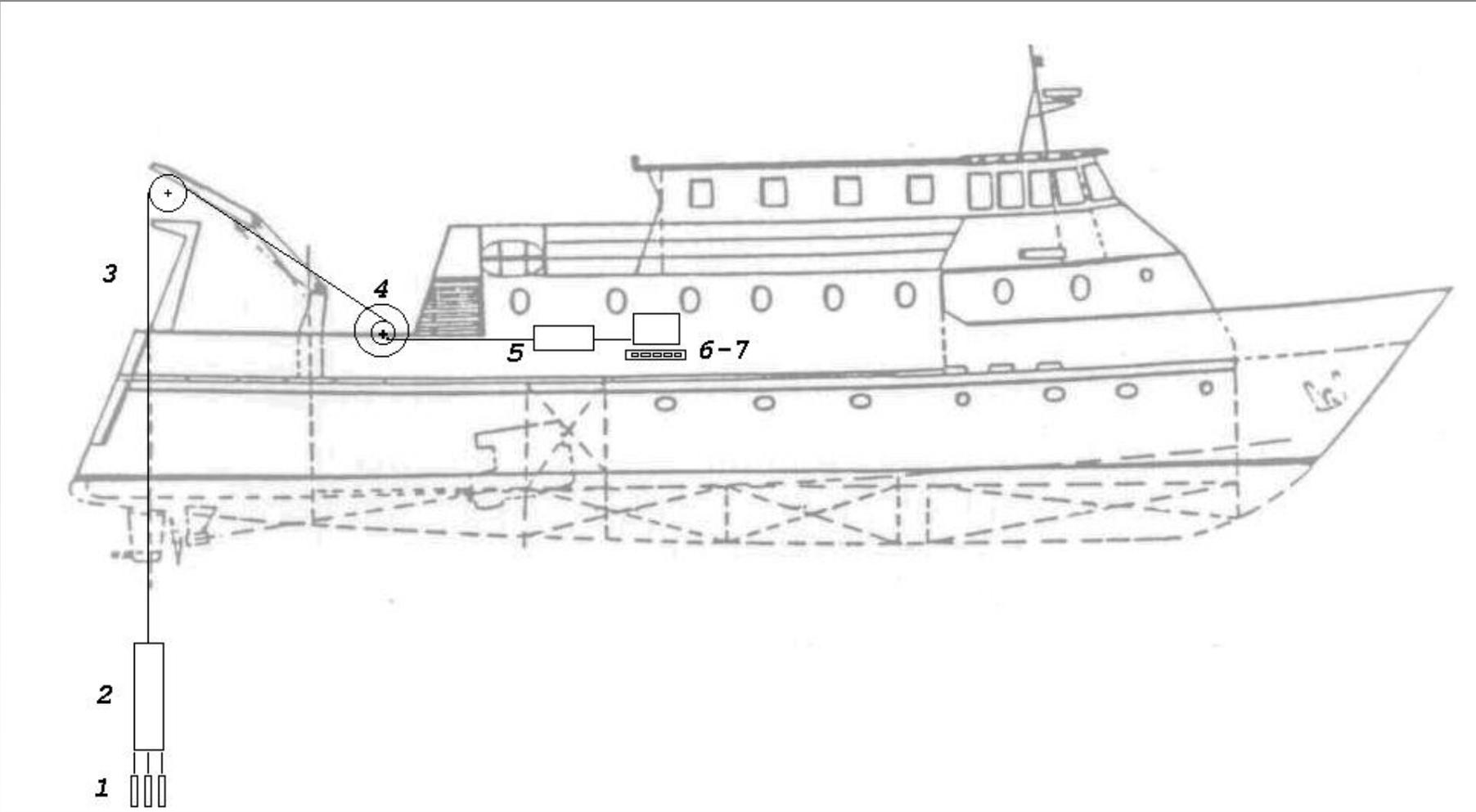


Internal memory scheme



Real time data transmission

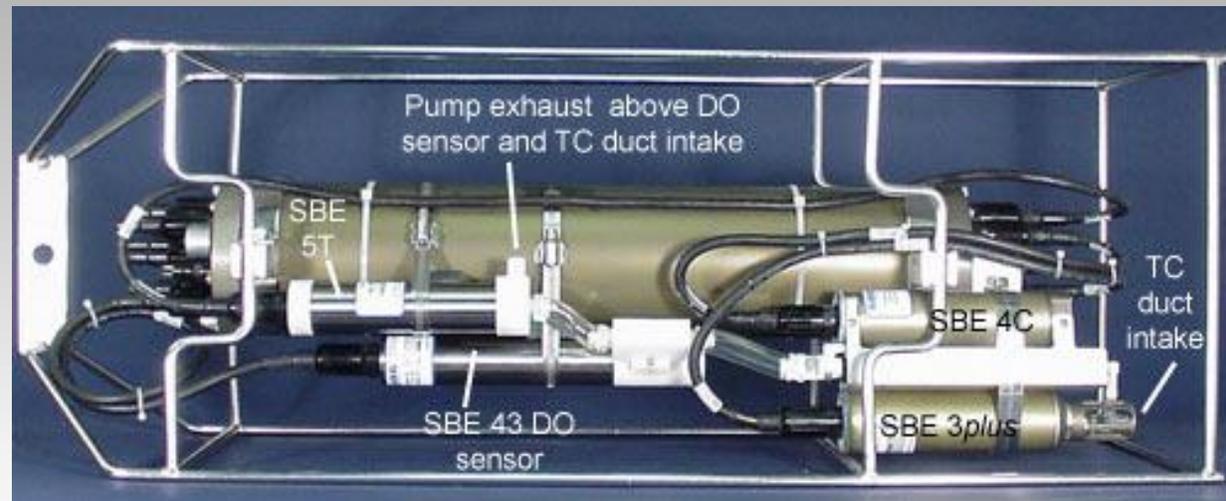




CTD multiparametric probes



SBE 911 plus Underwater Unit (UU)



Deck Unit (DU)



Visualizzazione dati alla DU (1)

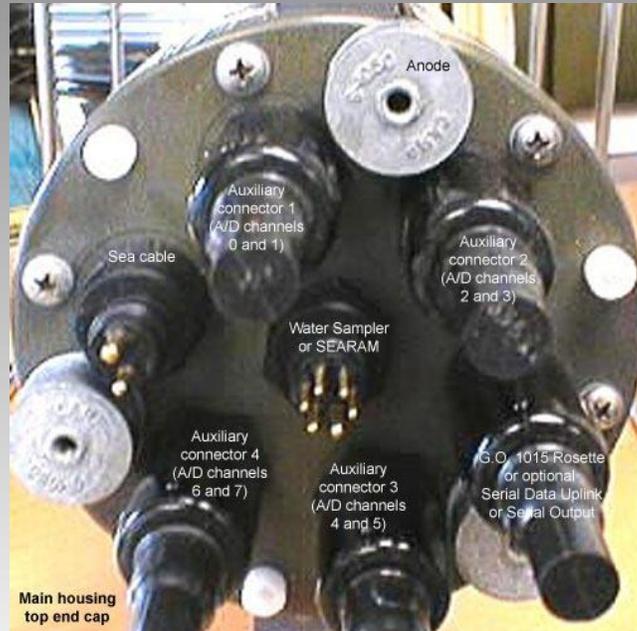
Display



Channel Selection

Deck Unit Display is useful to read the voltage from each sensor

Visualizzazione dati alla DU(2)



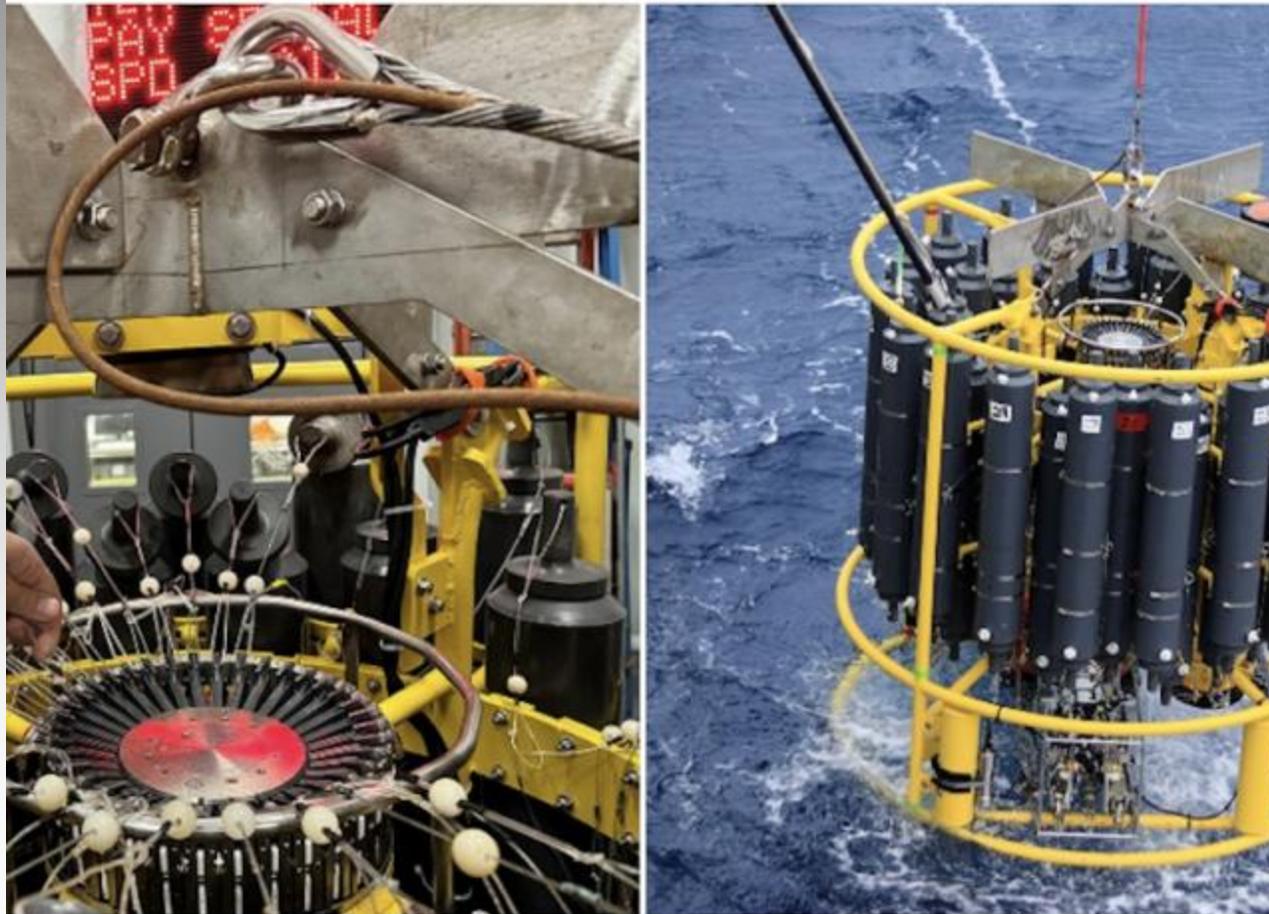
Sensor voltage is a well known parameter that can be useful for the test phases

Oceanographic cable



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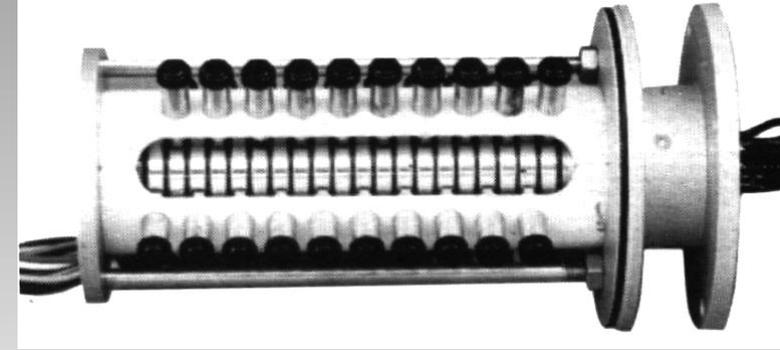
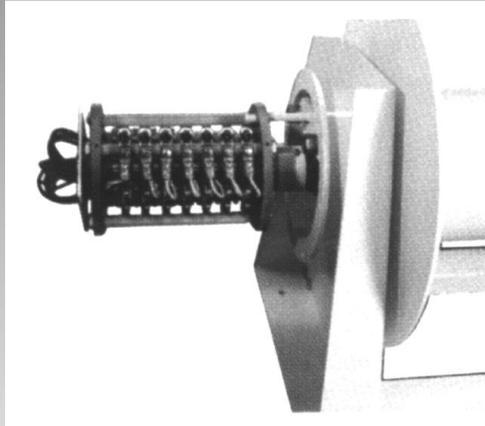


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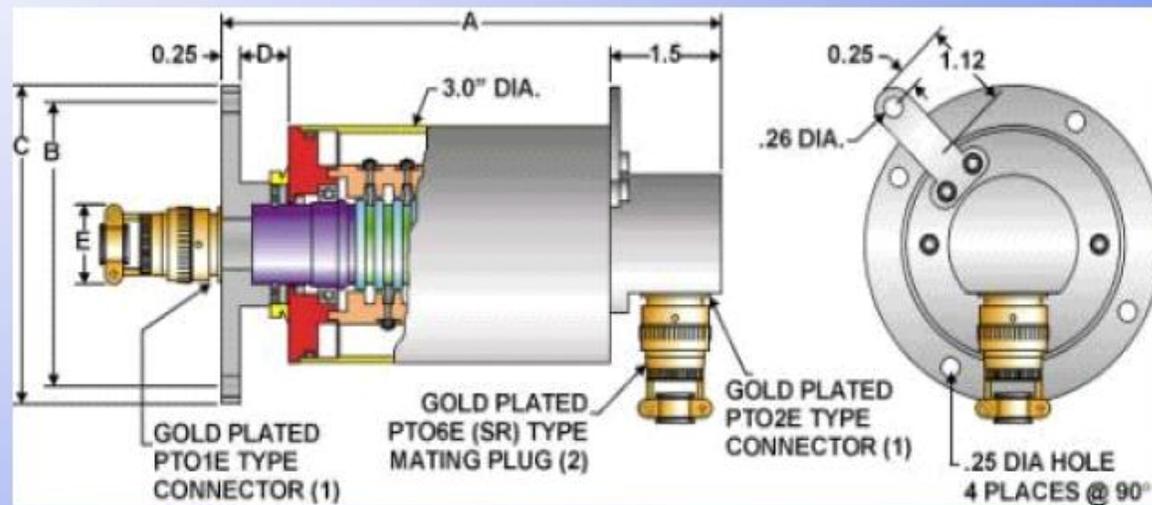
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Oceanographic Winch – Slip Rings



Slip Ring





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The SEACAT is configured with the SBE 5 pump to insure a reliable flow of water through the conductivity cell and optional dissolved oxygen sensor, regardless of descent rate.

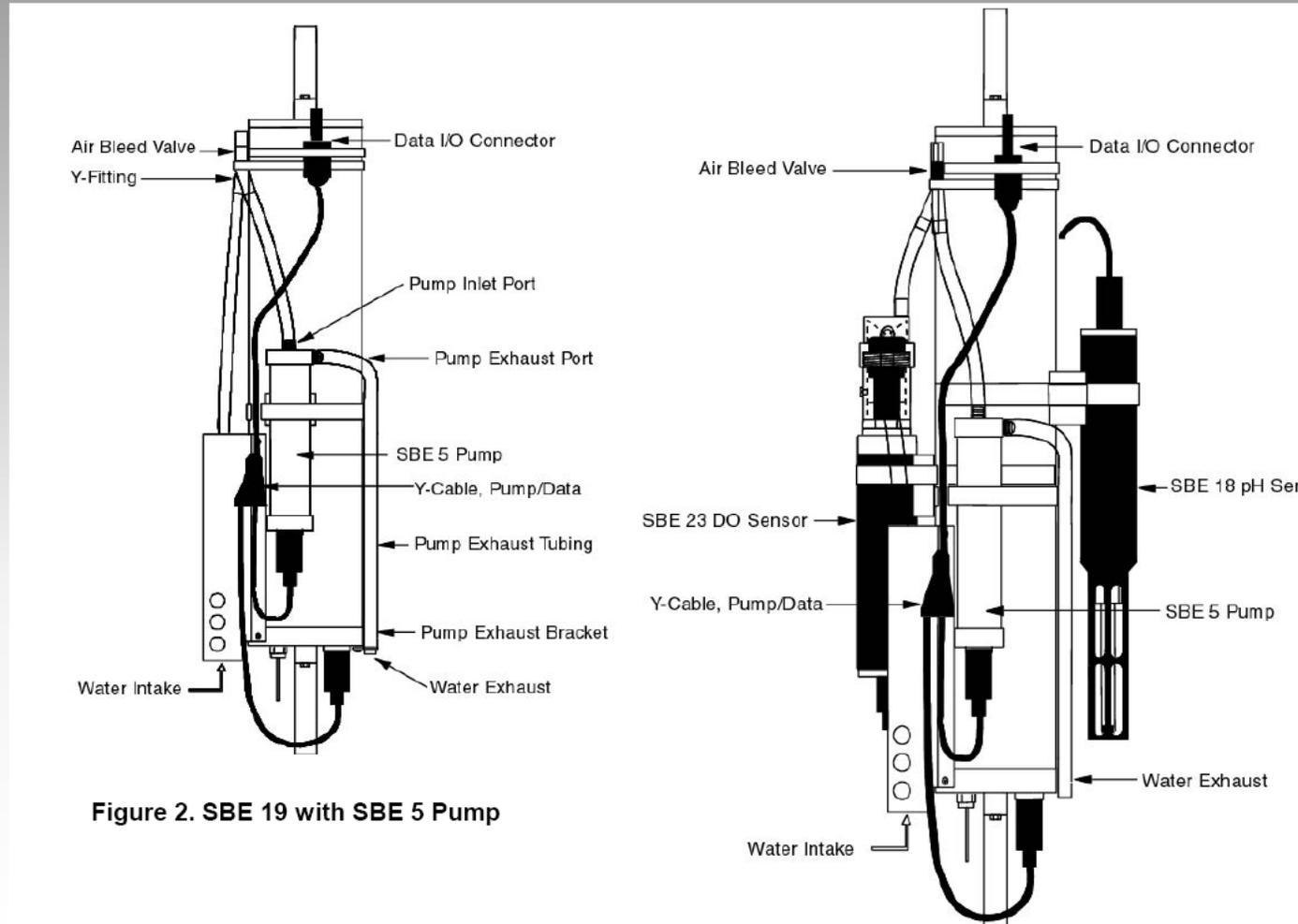
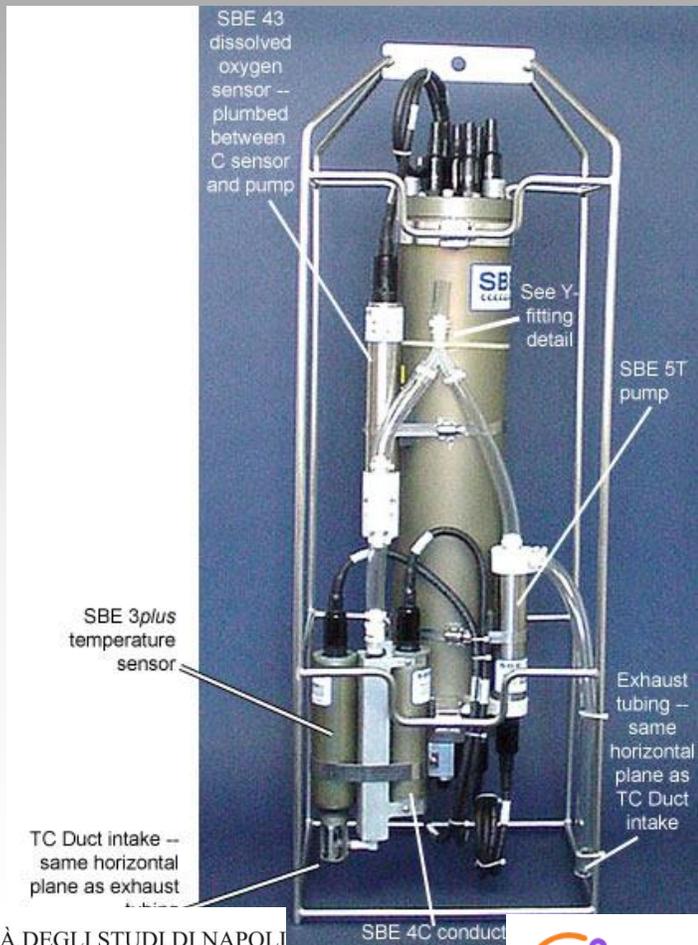


Figure 2. SBE 19 with SBE 5 Pump

BE 19 with SBE 5
solved Oxygen an

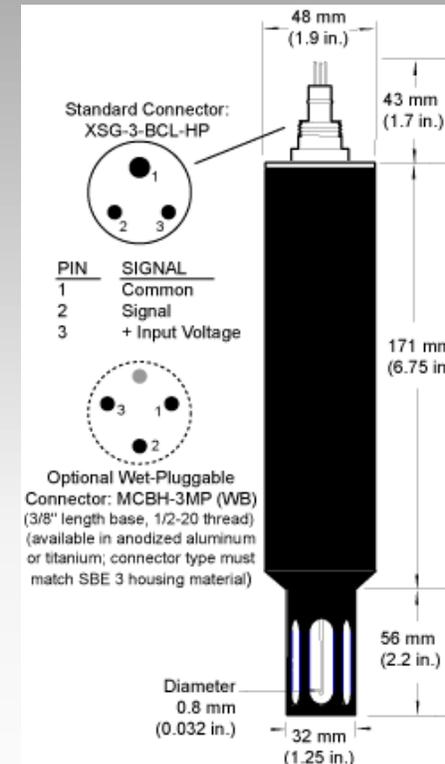
Preparazione del CTD per la misura (1)



Temperature probe (SBE3F)

SPECIFICATIONS (termistore)

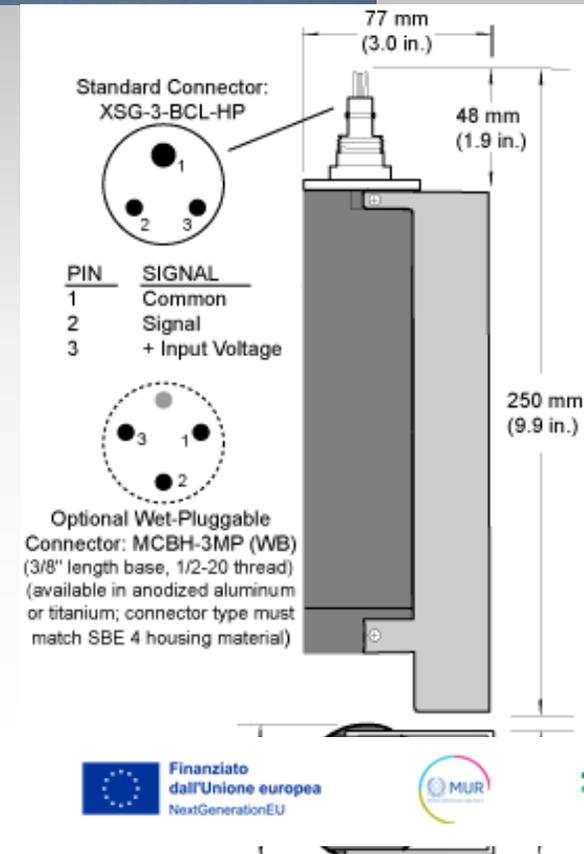
- **Range:** -5.0 to +35 °C
- **Initial Accuracy:** ± 0.001 °C
Stability: 0.002 °C per year typical
- **Response Time [seconds]:** (Time to reach 63% of final value following a step change in temperature)
 - 0.065 \pm 0.010 (1.0 m/s water velocity)
 - 0.070 \pm 0.010 (0.5 m/s water velocity)
- **Self-heating Error:** < 0.0001 °C in still water

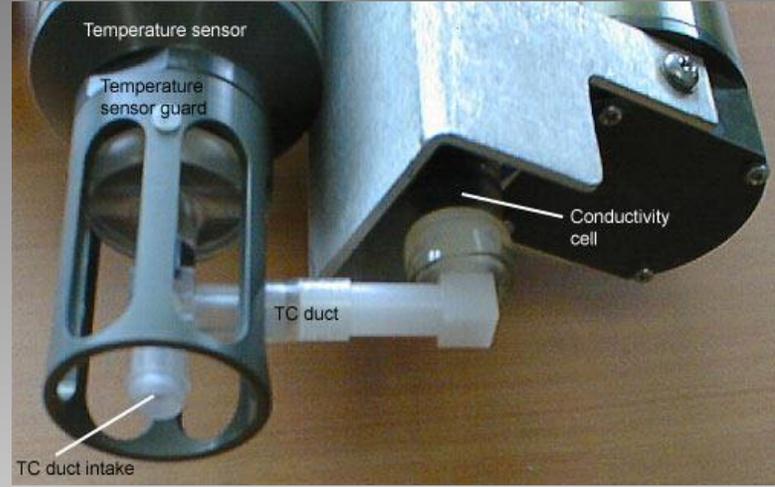


Conductivity sensor (SBE4C)

SPECIFICATIONS

- **Measurement Range:** 0.0 - 7.0 Siemens/meter (S/m)
- **Initial Accuracy:** 0.0003 S/m
- **Stability 2:** 0.0003 S/m/month
- **Resolution 3:** 0.00004 at 24 Hz
- **Time Response 4:** 0.060 seconds (pumped)





Pump



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TC duct

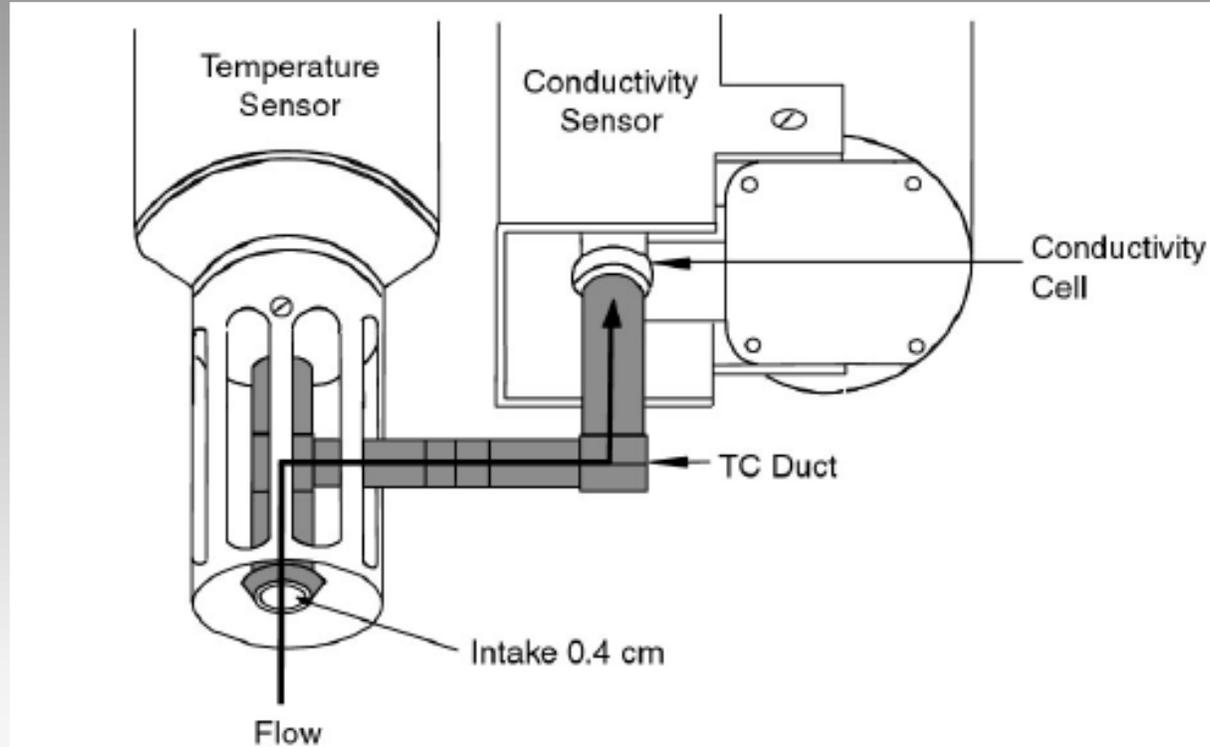


Figure 1. TC DUCT PHYSICAL ARRANGEMENT

Temperature Sensor calibration

CALIBRATION EQUATION

The calibration yields four coefficients (g, h, i, j) that are used in the following equation (Bennett):

$$T = \frac{1}{g + h \ln(f_0/f) + i \ln^2(f_0/f) + j \ln^3(f_0/f)} - 273.15, \quad [^{\circ}\text{C}]$$

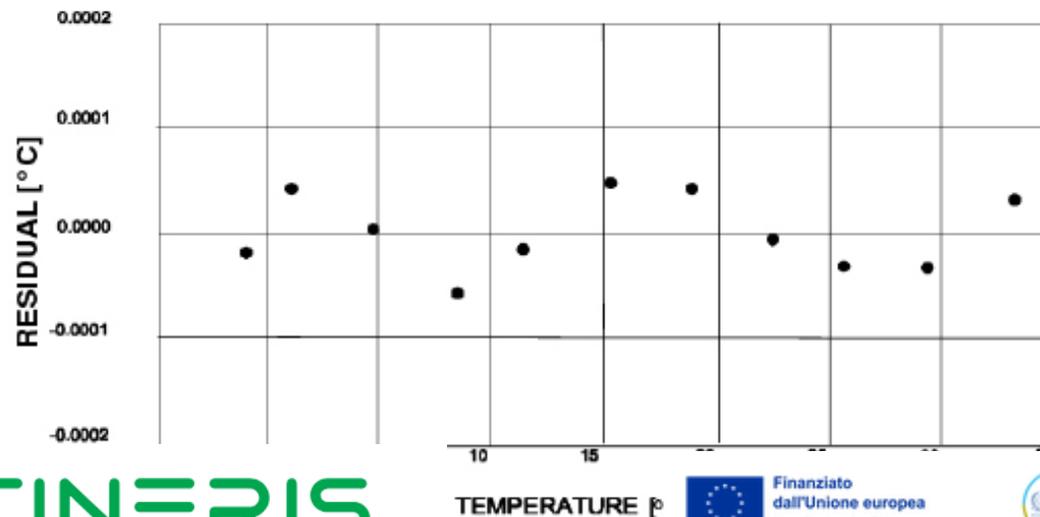
where T is temperature [$^{\circ}\text{C}$], \ln is the natural log function, and f is the SBE 3F output frequency in Hz. Note that f_0 , an arbitrary scaling term used for purposes of computational efficiency, was historically chosen as the lowest sensor frequency generated during calibration. For all calibration results expressed in terms of ITS-90 temperatures, the f_0 term is set to 1000. Calibration fit residuals are typically less than 0.0001°C .

ACTUAL CALIBRATION DATA for Sensor Serial Number 2234

CALIBRATION DATE: 01 Jun 96

g = 4.31635693e-03 h = 6.41530157e-04
 i = 2.27237634e-05 j = 2.17153096e-06
 $f_0 = 1000.000$

BATH TEMP [$^{\circ}\text{C}$]	INST FREQ [Hz]	INST TEMP [$^{\circ}\text{C}$]	RESIDUAL (INST - BATH) [$^{\circ}\text{C}$]
-1.4283	2787.505	-1.4283	-0.00002
1.0814	2948.210	1.0814	0.00004
4.5728	3182.770	4.5728	0.00000
8.1715	3438.281	8.1715	-0.00006
11.6037	3695.317	11.6037	-0.00001
15.1611	3975.833	15.1611	0.00005
18.6649	4266.480	18.6649	0.00004
	71.240	22.1634	
	96.542	25.7228	
	23.350	29.1375	
	77.028	32.6712	



Conductivity sensor calibration

CALIBRATION

Sea-Bird calibrates the sensor over the range of 2.6 to 6 S/m in a computer-controlled bath, using natural seawater; a water sample at each point is compared to IAPSO seawater using a Guildline AutoSal. A least-squares fitting technique (also including a zero conductivity point in air) yields calibration coefficients for use in the following equation:

$$\text{Conductivity} = \frac{g + hf^2 + if^3 + jf^4}{10 [1 + \delta t + \epsilon p]} \quad [\text{S/m}]$$

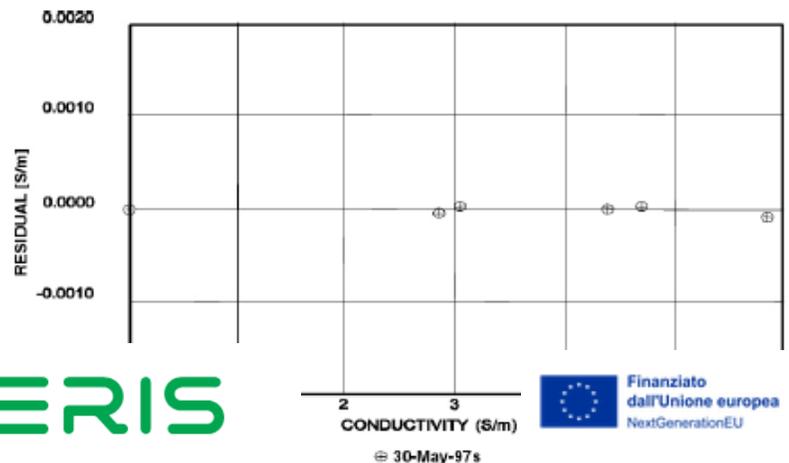
where f is instrument frequency [kHz], t is temperature [°C], p is pressure [decibars], and δ is thermal coefficient of expansion (3.25×10^{-6}) and ϵ is bulk compressibility (-9.57×10^{-6}) of the borosilicate cell. The resulting coefficients g , h , i , and j are listed on the calibration certificate. Residuals are typically less than 0.0002 S/m.

SAMPLE CALIBRATION DATA

CALIBRATION DATA FOR SENSOR SERIAL NUMBER = 2020
 CALIBRATION DATE: 30 May 97
 Practical Salinity Scale 1978: $C(35,15,0) = 4.2914$ [Siemens/meter]

$g = -1.056978777e+01$ $i = -4.32023820e-03$
 $h = 1.42707291e+00$ $j = 4.53455585e-04$

BATH TEMP [°C68]	BATH SAL [ppt]	BATH COND [S/m]	INST FREQ [kHz]	INST COND [S/m]	RESIDUAL (INST - BATH) [S/m]
0.0000	0.0000	0.00000	2.72957	0.00000	0.00000
-1.3428	35.2722	2.80855	5.22318	2.80850	-0.00005
1.0000	35.2724	3.01943	5.36370	3.01947	0.00004
15.0000	35.2731	4.34337	6.00000	4.34337	0.00000
15.0000	35.2731	4.69132	6.00000	4.69132	0.00000
15.0000	35.2708	5.77613	6.00000	5.77613	0.00000
15.0000	35.2657	6.15878	7.00000	6.15878	0.00000



Configuration file (.con)(1)

- Lanciare SeaSave e cliccare sul menù Configure Inputs

The screenshot displays the SeaSave software interface with the following components:

- Fixed Display 1:** A list of parameters with checkboxes for display. The parameters are: Scan Count, Pressure, Digiquartz [db], Depth [salt water, m], Temperature [ITS-90, deg C], Conductivity [S/m], Salinity [PSU], Oxygen Saturation [ml/l], Oxygen, SBE 43 [% saturation], pH, OBS, Seapoint Turbidity [FTU], and Fluorescence, Wetlab Wetstar [mg/m³].
- Sequential Bottle Fire:** A control window with "#Fired: 0", "Next bottle to be fired:" (set to 1), and a "Fire Bottle" button. It also includes a "Bottle Firing Sequence" text area.
- NMEA Data:** A window showing "Latitude: 39° 42.499' N", "Longitude: 13° 37.009' E", and "Date/Time: 16 Jan 2009".
- Mark Scan Control:** A window with "# Marks: 0" and a "Mark Scan" button.
- Plot Display 1:** A large plot area with a vertical axis labeled "Depth [salt water, m]" ranging from 0,000 to 280,000 and a horizontal axis labeled "Conductivity [S/m]" ranging from 4,600 to 6,000. The plot area is currently empty.



Configuration file (.con)(2)

The screenshot displays the 'Seasave' software interface. The main window is titled 'Seasave - SBE 911plus/917plus CTD - C:\Programmi\Sea-Bird\SeasaveV7\Seasave.psa*'. The 'Configure Inputs' dialog box is open, showing the configuration for the file 'vetimer_good.CON'. The dialog has three tabs: 'TCP/IP Ports', 'Miscellaneous', and 'Pump Control'. The 'Miscellaneous' tab is active, showing the following configuration:

- Configuration file opened: vetimer_good.CON
- Instrument type: 911plus/917plus CTD
- Frequency channels suppressed: 0
- Voltage words suppressed: 0
- Computer interface: RS-232C
- Scans to average: 1
- Surface par voltage added: Yes
- Scan time added: No
- NMEA position data added: Yes
- Channel: Sensor
- 1. Frequency: Temperature
- 2. Frequency: Conductivity
- 3. Frequency: Pressure, Digiquartz with TC
- 4. Frequency: Temperature, 2
- 5. Frequency: Conductivity, 2
- 6. A/D voltage 0: Oxygen, SBE 43
- 7. A/D voltage 1: Oxygen, SBE 43, 2
- 8. A/D voltage 2: Altimeter
- 9. A/D voltage 3: Free
- 10. A/D voltage 4: Transmissometer, Chelsea/Seate
- 11. A/D voltage 5: Fluorometer, Chelsea Aqua 3
- 12. A/D voltage 6: Near Polaromial

The background shows a plot display with a grid. The x-axis is labeled 'Temperature [ITS-90, deg C]' and ranges from 15,000 to 30,000. The y-axis is labeled 'S/m' and ranges from 5,400 to 6,000. Other windows visible include 'Fixed Display 1' (listing various parameters like Scan Count, Pressure, Depth, etc.), 'Sequential Bottle Fire' (showing #Fired: 0 and Next bottle to be fired: 1), and 'NMEA Data' (showing Latitude: 39° 42.499' N, Longitude: 13° 37.009' E, Date/Time: 16 Jan 2009 01:52:26).

re un file .con già esistente e si crea un nuovo o si modifica uno già



Configuration file (.con)(3)

Seasave - SBE 911plus/917plus CTD - C:\Programmi\Sea-Bird\SeasaveV7\Seasave.psa*

File Configure Inputs Configure Outputs Display Real-Time Data Real-Time Control Archived Data Options Help

vetimer_good.CON

Fixed Display 1

Scan Count	
Pressure, Digiquartz [db]	
Depth [salt water, m]	
Temperature [ITS-90, deg C]	
Conductivity [S/m]	
Salinity [PSU]	
Oxygen Saturation [ml/l]	
Oxygen, SBE 43 [% saturation]	
pH	
OBS, Seapoint Turbidity [FTU]	
Fluorescence, Wetlab Wetstar [mg/m ³]	

Sequential Bottle Fire

#Fired: 0

Next bottle to be fired: 1

Fire Bottle

Bottle Firing Sequence

NMEA Data

Latitude 39° 42.499' N

Longitude 13° 37.009' E

16 Jan 2009

Mark Scan Control

Marks: 0

Mark Scan

Configuration for the SBE 911plus/917plus CTD

Configuration file opened: vetimer_good.CON

Frequency channels suppressed 0

Voltage words suppressed 0

Computer interface RS-232C

Scans to average 1

Surface PAR voltage added Scan time added

NMEA position data added

Channel	Sensor
1. Frequency	Temperature
2. Frequency	Conductivity
3. Frequency	Pressure, Digiquartz with TC
4. Frequency	Temperature, 2
5. Frequency	Conductivity, 2
6. A/D voltage 0	Oxygen, SBE 43
7. A/D voltage 1	Oxygen, SBE 43, 2
8. A/D voltage 2	Altimeter
9. A/D voltage 3	Free
10. A/D voltage 4	Transmissometer, Chelsea/Seatech/Wetlab
11. A/D voltage 5	Fluorometer, Chelsea Aqua 3
12. A/D voltage 6	User Polynomial
13. A/D voltage 7	Free
14. SPAR voltage	Unavailable
15. SPAR voltage	SPAR/Surface Irradiance

Report... Help... Exit Cancel

Plot Display 1

S/m] 5,400 5,600 5,800 6,000



Configuration file (.con)(4)

The screenshot shows the Seasave software interface for configuring an SBE 911plus/917plus CTD. The main window displays various data fields and a plot area. Overlaid windows include:

- Fixed Display 1:** A list of data fields with checkboxes, including Scan Count, Pressure, Depth, Temperature, Conductivity, Salinity, Oxygen Saturation, pH, and Fluorescence.
- Plot Display 1:** A plot area showing data points and a grid. The x-axis is labeled 'S/m' and ranges from 5,400 to 6,000.
- Configuration for the SBE 911plus/917plus CTD:** A dialog box for configuring the CTD. It shows the configuration file path (vetimer_good.CON) and various settings for frequency channels, voltage words, and computer interface. A 'Temperature' sub-dialog is also open, showing the serial number (4440) and calibration date (050208).
- Temperature:** A dialog box for configuring the temperature sensor. It shows the serial number (4440) and calibration date (050208). It also includes fields for G, H, I, J, F0, Slope, and Offset.
- Sequential Bottle Fire:** A dialog box for configuring the bottle firing sequence. It shows the number of bottles fired (#Fired: 0) and the next bottle to be fired (1).
- NMEA Data:** A dialog box for displaying NMEA data, including Latitude (39° 42.499' N) and Longitude (13° 37.009' E).
- Mark Scan Control:** A dialog box for marking scans, showing the number of marks (#Marks: 0) and a 'Mark Scan' button.



Normally, the conductivity cell must be in water before the pump runs.

After the cell enters the water, there is a delay before turn-on so that all the air in the pump tubing can escape.



**sample rate
from 0.04 s
to 4 min**

**descent rate
1 m/s**



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- **Measurement Range:**

Temperature -5 to +35 °C

Conductivity 0 to 7 S/m (0 to 70 mmho/cm)

Pressure

- *Strain Gauge Sensor* 100, 150, 300, 500, 1000, 1500, 3000, 5000, 10000, or 15000 psia
- *Digiquartz Sensor* 100, 200, 300, 400, 1000, 2000, 3000, 6000, 10000, or 15000 psia

- **Accuracy:**

Temperature 0.01 °C

Conductivity 0.001 S/m

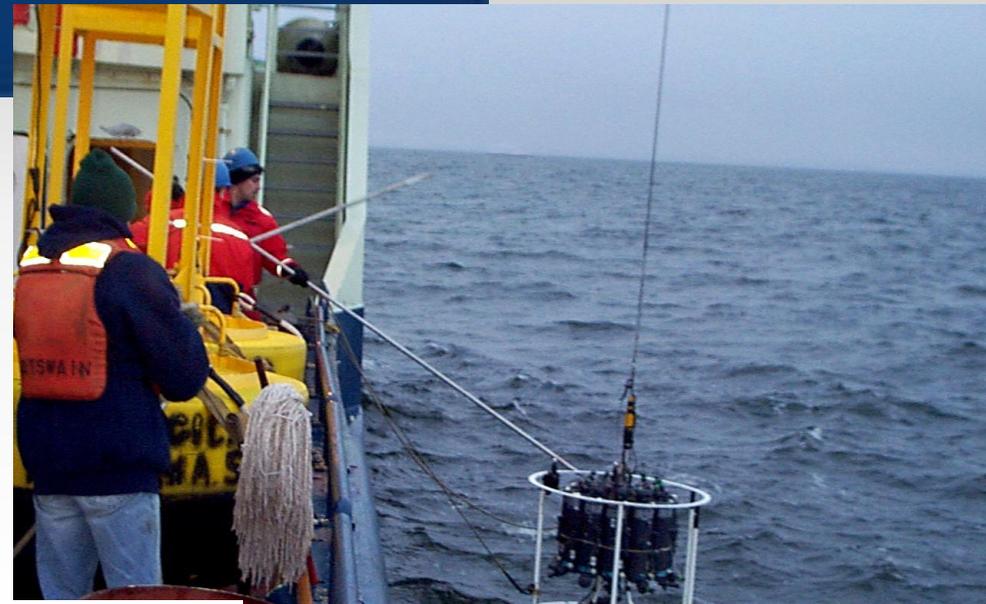
Pressure

- *Strain Gauge Sensor* 0.25% of full scale range (100 - 1500 psia)
- 0.15% of full scale range (3000 - 15000 psia)
- *Digiquartz Sensor* 0.02% of full scale range





In every single station the research vessel must stop to allow the measurement of the parameters along the water column



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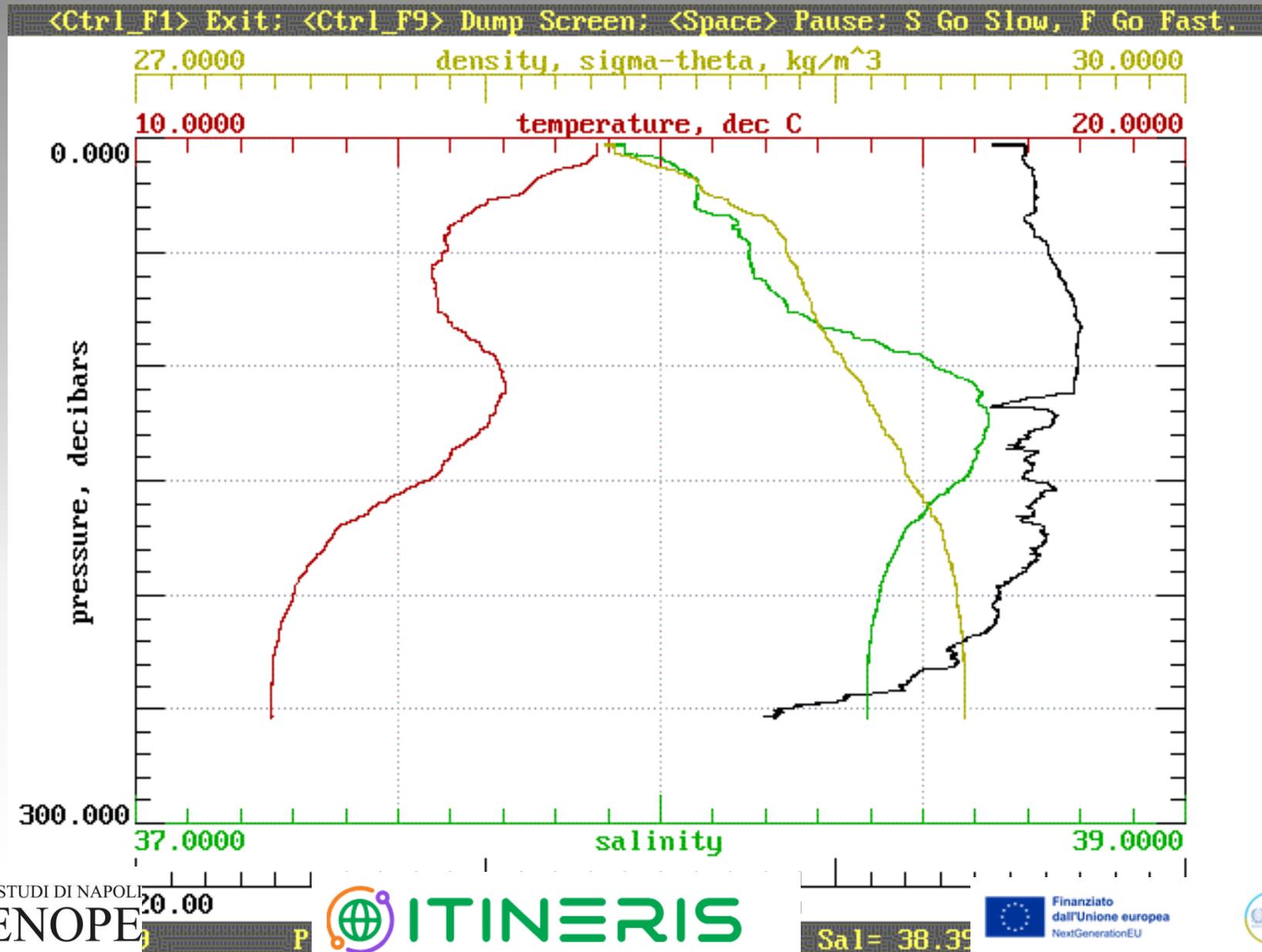




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Data Acquisition Using SeaSoft



Sampling through bottles (1)

The screenshot displays the Seasave software interface for an SBE 911plus/917plus CTD. The main window shows a configuration file named 'vetimer_good.CON'. A 'Configure Inputs' dialog box is open, showing the 'Pump Control' tab with 'Water Sampler' selected. The 'Configuration file opened' is 'vetimer_good.CON', and the 'Instrument type' is '911plus/917plus CTD'. The 'Sensor' list includes Temperature, Conductivity, Pressure, Digiquartz with TC, Temperature, 2, Conductivity, 2, Oxygen, SBE 43, Oxygen, SBE 43, 2, Altimeter, Free, Transmissometer, Chelsea/Seate, and Fluorometer, Chelsea Aqua 3. A 'Fixed Display 1' window shows a list of parameters with checkboxes. A 'Sequential Bottle Fire' window shows '#Fired: 0' and 'Next bottle to be fired: 1'. A 'NMEA Data' window shows Latitude: 39° 42.499' N, Longitude: 13° 37.009' E, and Date/Time: 16 Jan 2009 01:52:26. A 'Mark Scan Control' window shows '# Marks: 0' and a 'Mark Scan' button. A plot window shows a grid with a y-axis labeled 'S/m' and x-axis values 5,400, 5,600, 5,800, 6,000.



Sampling through bottles (2)

The screenshot displays the Seasave software interface with several windows open:

- Fixed Display 1:** A table listing various parameters with checkboxes for selection:

Scan Count	<input type="checkbox"/>
Pressure, Digiquartz [db]	<input checked="" type="checkbox"/>
Depth [salt water, m]	<input checked="" type="checkbox"/>
Temperature [ITS-90, deg C]	<input checked="" type="checkbox"/>
Conductivity [S/m]	<input checked="" type="checkbox"/>
Salinity [PSU]	<input checked="" type="checkbox"/>
Oxygen Saturation [ml/l]	<input checked="" type="checkbox"/>
Oxygen, SBE 43 [% saturation]	<input checked="" type="checkbox"/>
pH	<input checked="" type="checkbox"/>
OBS, Seapoint Turbidity [FTU]	<input checked="" type="checkbox"/>
Fluorescence, Wetlab Wetstar [mg/m ³]	<input checked="" type="checkbox"/>
- Sequential Bottle Fire:** Shows "#Fired: 0" and "Next bottle to be fired: 1". A "Fire Bottle" button is present.
- NMEA Data:** Displays "Latitude 39° 42.499' N", "Longitude 13° 37.009' E", and "16 Jan 2009".
- Mark Scan Control:** Shows "#Marks: 0" and a "Mark Scan" button.
- Configure Inputs - C:\Programmi\Sea-Bird\SeasaveV7\Seasave.psa:** A dialog box with tabs for "TCP/IP Ports", "Miscellaneous", and "Pump Control". The "Water Sampler" sub-tab is active, showing:
 - Water sampler type: GO 1016
 - Select the serial port for water sampler operation on the Serial Ports tab.
 - Number of Water Bottles: 12
 - Firing sequence: Sequential
 - Enable remote firing (not implemented yet)
 - Buttons: "Bottle Positions for Table Driven" and "Auto-Fire Pressures & Positions"
- Plot Display 1:** A graph showing a data series over time. The x-axis is labeled with values 5,400, 5,600, 5,800, and 6,000. The plot area is currently empty with a dashed grid.

At the bottom of the interface, there are buttons for "Report", "Help", "OK", and "Cancel".



Header file

Sono posti all'inizio di ogni file dati:

- * Sea-Bird SBE 9 Data File:
- * FileName = C:\vector\VTM2.HDR
- * Software Version Seasave Win32 V 5.33
- * Temperature SN = 183
- * Conductivity SN = 923
- * Number of Bytes Per Scan = 37
- * Number of Voltage Words = 5
- * Number of Scans Averaged by the Deck Unit = 1
- * Append System Time to Every Scan
- * System UpLoad Time = Nov 23 2006 16:37:26
- ** Ship: R/V Urania
- ** Cruise: vector
- ** Station: VTM02
- *END*



File di Mark

C:\vector\VTM2.mrk:

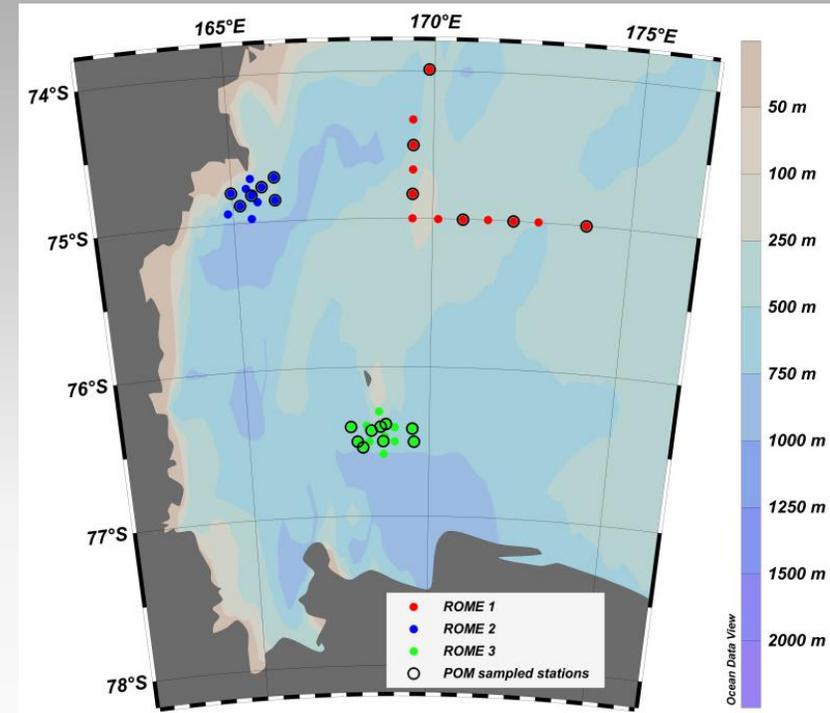
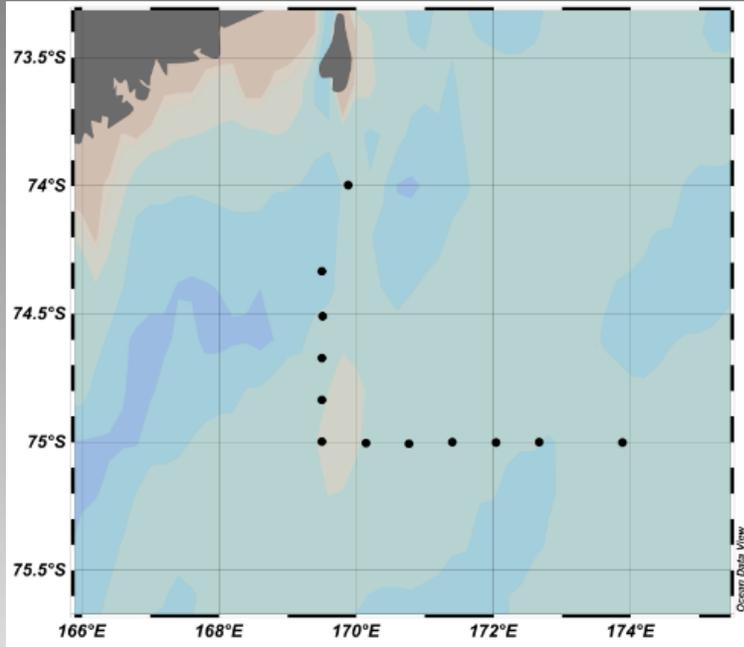
Scan,	DepthS,	TempS90M,	CondSmS/cm,	TempP90M,	CondPmS/cm,	SalnP,	OxML/L
mark number 1, system time is Nov 23 2006 17:33:07							
80228.0,	2674.0,	13.440,	46.248,	13.436,	46.253,	38.500,	0.0
mark number 2, system time is Nov 23 2006 17:33:18							
80487.0,	2673.3,	13.440,	46.248,	13.436,	46.253,	38.500,	0.0
mark number 3, system time is Nov 23 2006 17:38:23							
87799.0,	2499.5,	13.416,	46.155,	13.412,	46.159,	38.502,	0.0
mark number 4, system time is Nov 23 2006 17:44:12							
96185.0,	2250.2,	13.382,	46.018,	13.379,	46.023,	38.504,	0.0



Oceanographic cruise planning

- Why
- Where
- When
- Resolution
- Instruments
- Costs





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PARTHENOPE



**Vector 1 (Novembre 2006-
Urania)**

**Vector 2 (Febbraio 2007-
Urania)**

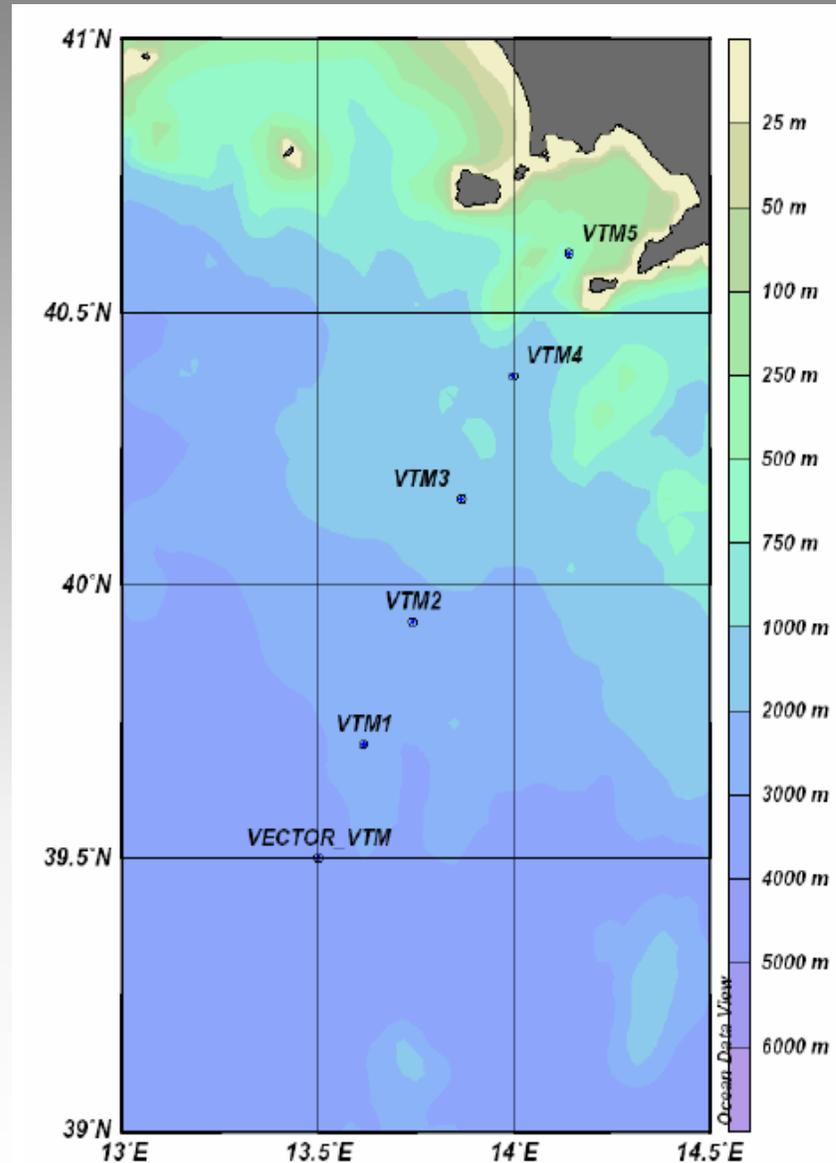
**Vector 3 (Aprile 2007 -
Universitatis)**

**Vector 4 (Maggio-Giugno
2007**

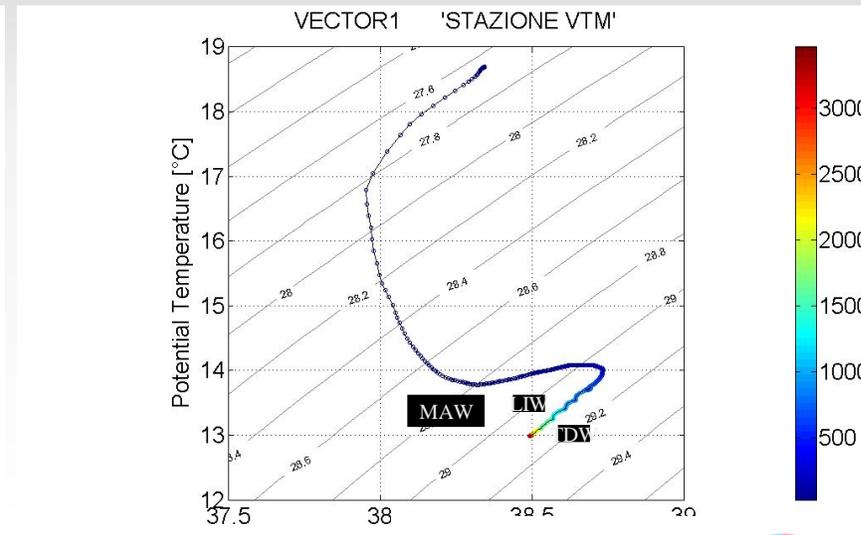
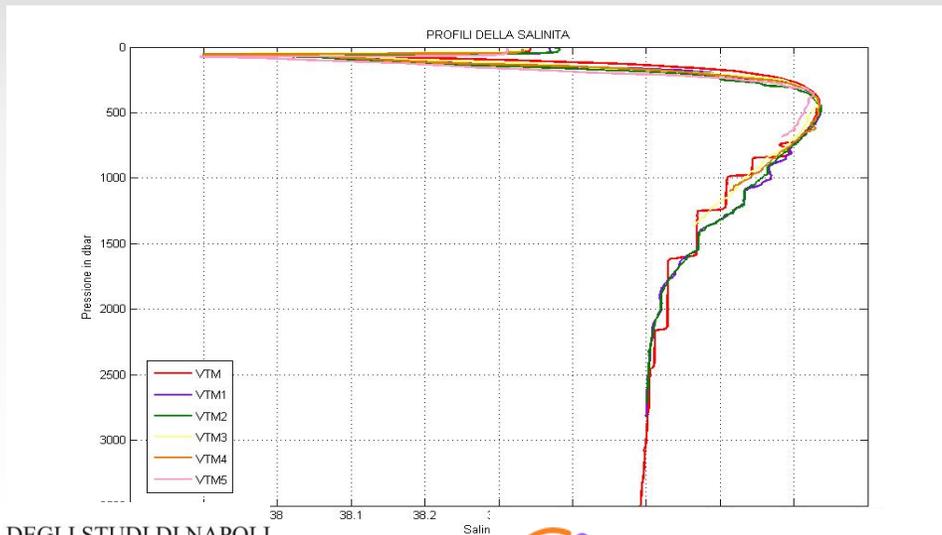
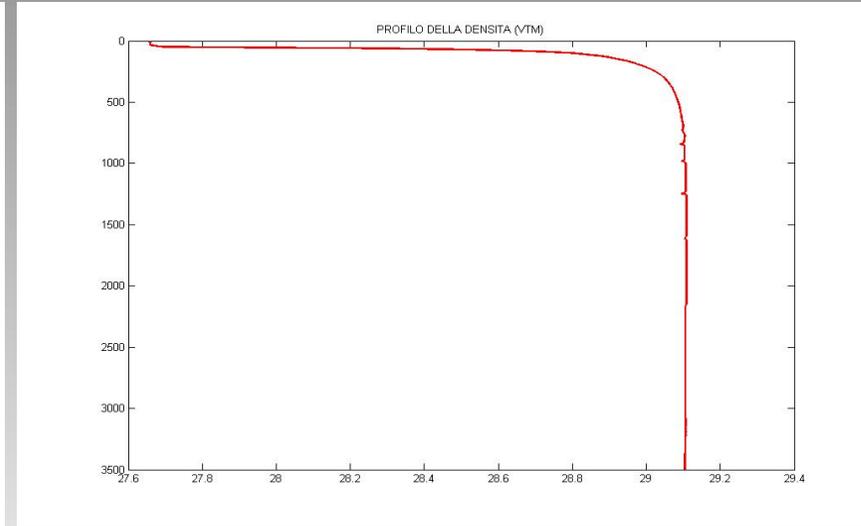
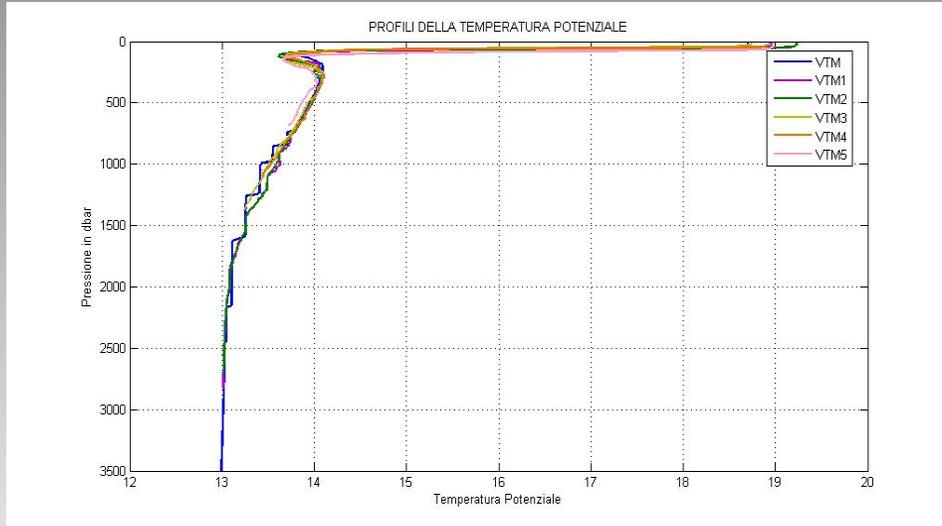
TransMed - Urania)

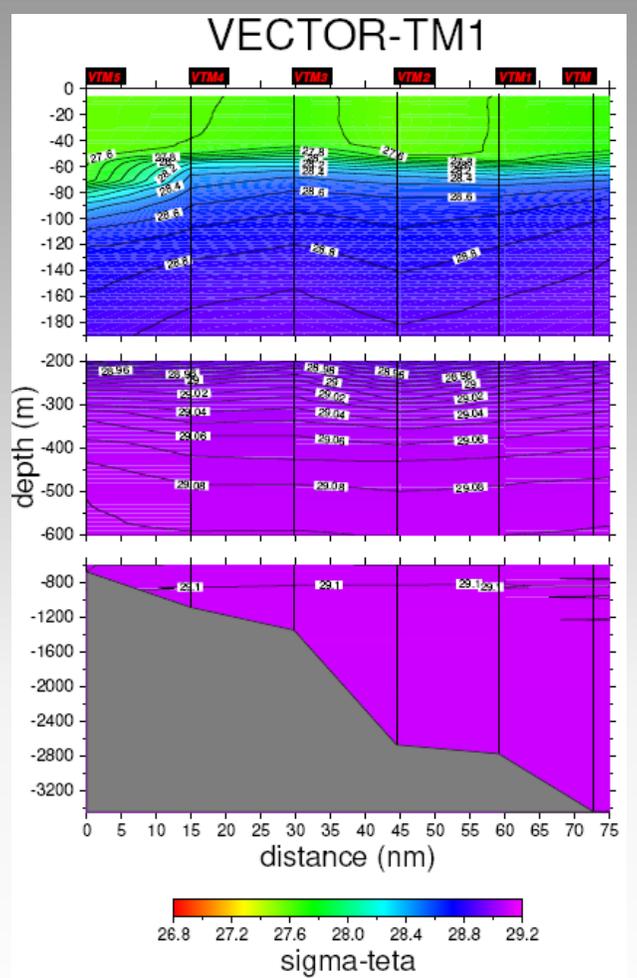
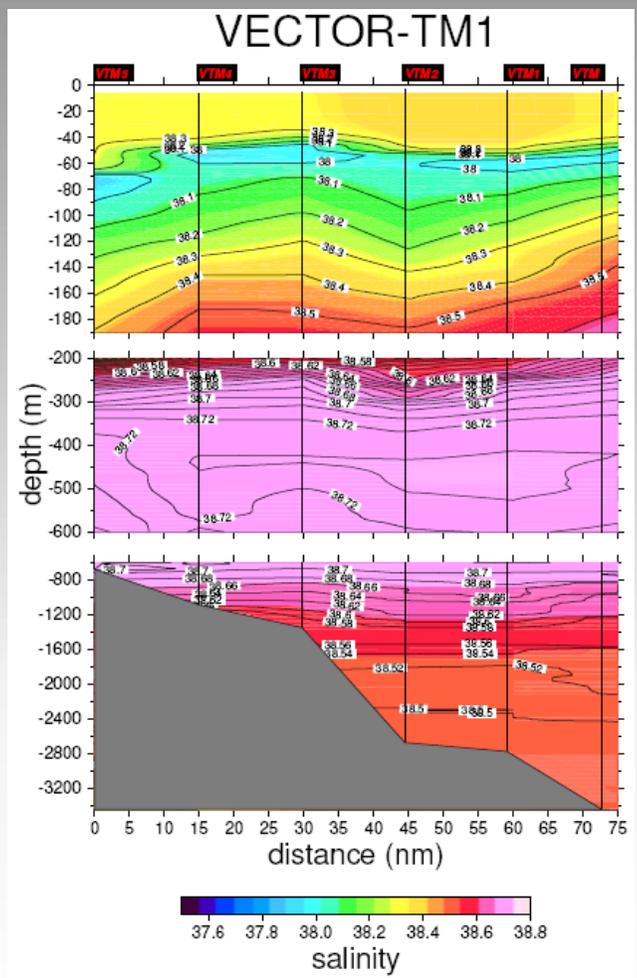
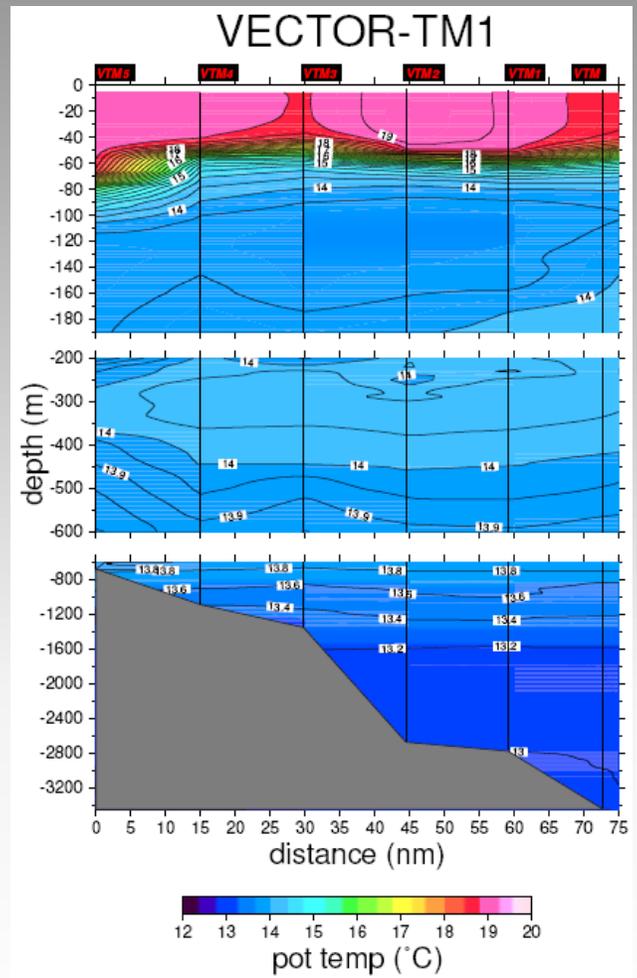
**Vector 5 (Febbraio 2008 -
Universitatis)**

**Vector 6 (Gennaio 2009 -
Urania)**



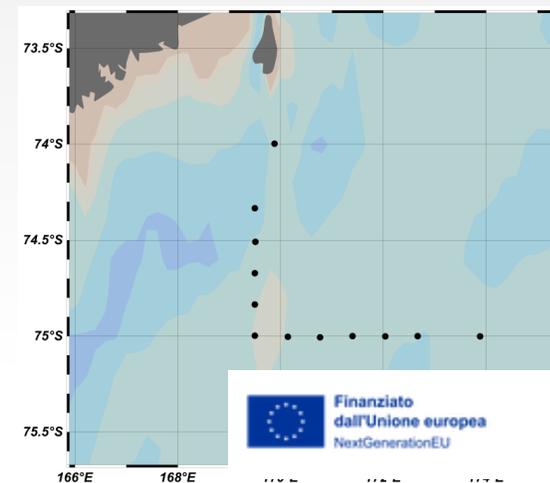
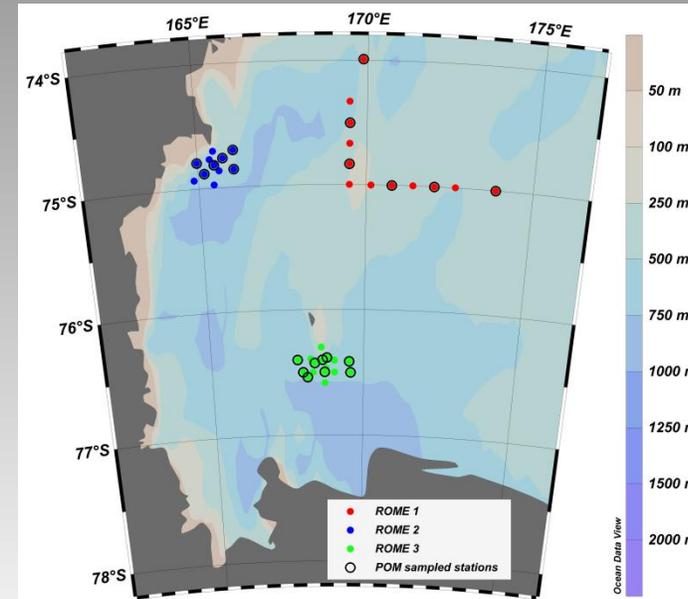
CTD data plotting





The traditional EULERIAN oceanographic data collection

Each oceanographic cruise is based on a sampling plan that is designed according to the aims of the scientific project

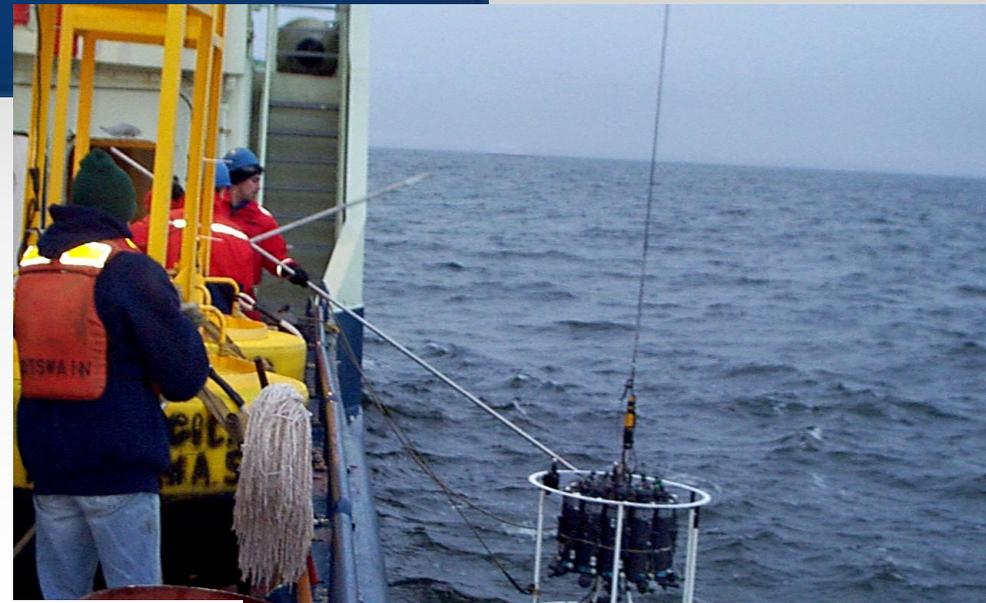


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PARTHENOPE





In every single station the research vessel must stop to allow the measurement of the parameters along the water column



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PARTHENOPE

 **ITINERIS**



Oceanographic Research Vessel



Classe ghiaccio

Lunghezza: 130 m

Larghezza: 17.3 m

Pescaggio: 6.93 m

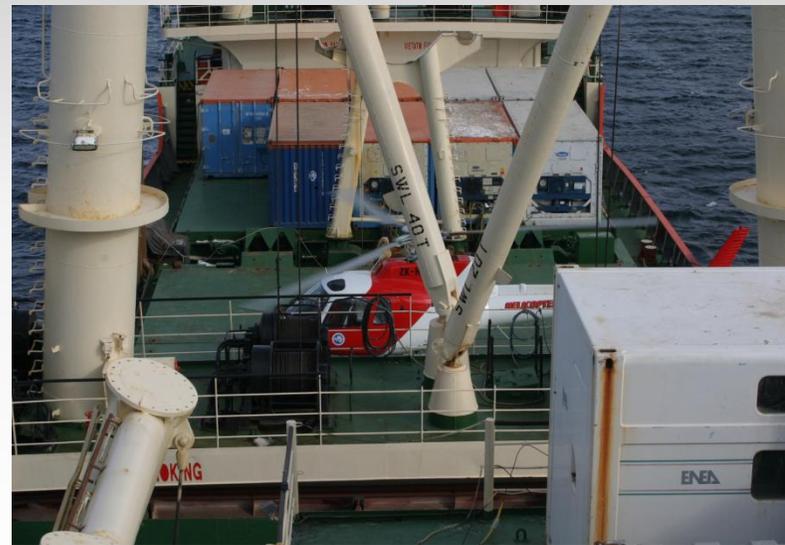
Stazza lorda: 6.000 t

Equipaggio: 93 membri

Personale scientifico:

27 membri





N/R LAURA BASSI

Nave da Ricerca per esplorazioni geofisiche e oceanografiche
Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS



Istituto Nazionale di Oceanografia
e di Geofisica Sperimentale



HELI DECK POPPIERO

con portellone di comunicazione
all'area di lavoro
Peso elicottero: 10 tonnellate (Super Puma)



GRU CARGO

Portata: 50 tonnellate



GRU TELESCOPICA

Portata: 10 tonnellate.
Adatta a movimentazione,
sollevamento e messa a mare
strumentazione scientifica



LAURA BASSI

(1711 – 1778)

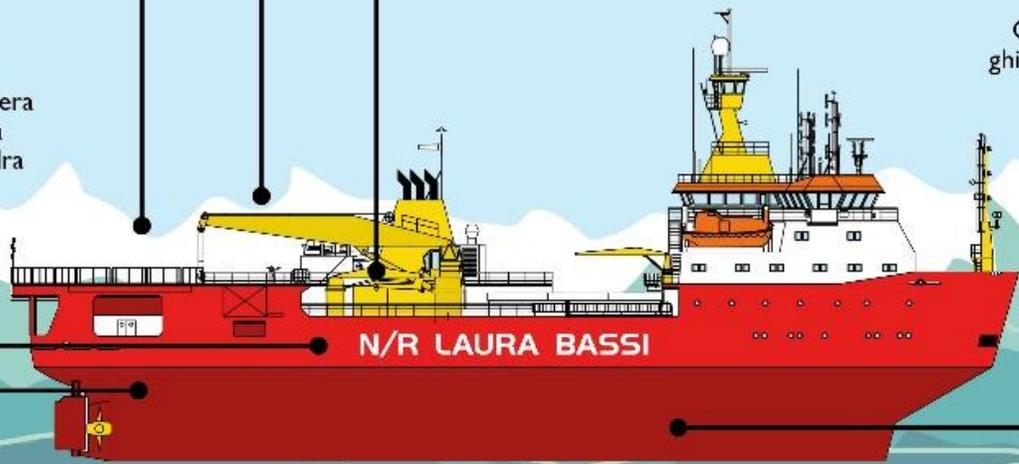
Fisica e accademica italiana.
Seconda donna laureata d'Italia,
prima a intraprendere una carriera
accademica e scientifica e prima
al mondo a ottenere una cattedra
universitaria



ROMPIGHIACCIO

Icebreaker ICE 05 E0
Capacità di rompere il
ghiaccio fino ad 1 metro

DOPPIO
SCAFO



STIVA
3.000 m³

80 metri

AREA
ATTIVITÀ
SCIENTIFICHE

AREA
CARGO

AREA
COMANDO E ALLOGGI



CARATTERISTICHE GENERALI

Nome: LAURA BASSI

Proprietà: Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS

Tipo: Rompighiaccio ICE 05 E0

Anno di costruzione: 1995

Posizionamento dinamico: secondo livello (DP2)

Attività di ricerca: Geofisica e Oceanografia



Lunghezza: 80 metri

Larghezza: 17 metri

Stazza: 4.028 tonnellate



Autonomia: 60 giorni



Potenza installata: 5.100 kW (7315 Hp)

Velocità di crociera: 12 nodi



Combustibile:

gasolio marino a bassissima percentuale di zolfo nelle casse nave
carburante per aviazione Jet A-1 in serbatoi separati

CAPACITÀ ALLOGGIAMENTO

50

personale scientifico



22

equipaggio



37

ALLOGGI



TEMPO LIBERO



Mensa



Zone ricreative



Lavanderie



Palestra



Spogliatoi dedicati



Sauna

1



OSPEDALE

1

LABORATORIO ASCIUTTO



- Superficie: 45 m²
- Banchi di lavoro
- Accesso diretto all'area operazioni di poppa

1

LABORATORIO UMIDO



- Superficie: 45 m²
- Interni in acciaio inossidabile
- Prese e scarico acqua dolce e salata
- Accesso diretto all'area operazioni di poppa

+2

ALLOGGIAMENTI PER CONTAINER LABORATORIO



Tipo: ISO 20 ft con collegamento diretto all'area operazioni di poppa

4.028 tonnellate

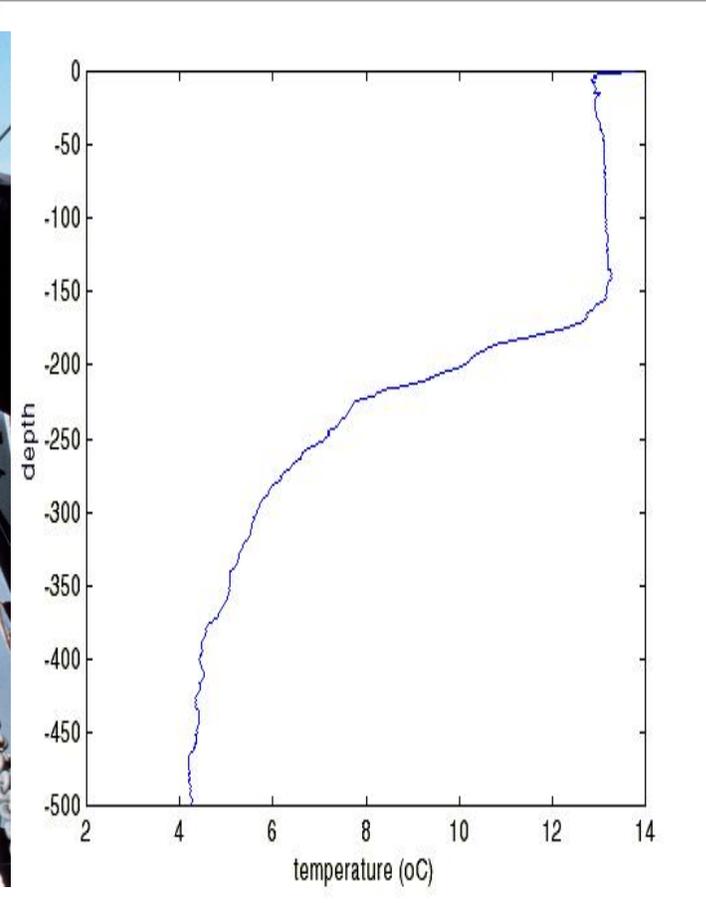
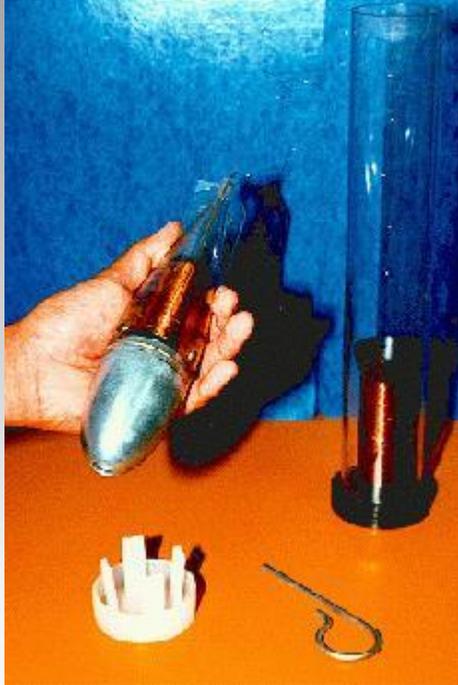


EXPENDABLE PROBES



These probes can be used for ongoing data collection along depth but most of them cannot be retrieved and have a limited depth range

Expandable Bathy-Thermograph XBT



NO PRESSURE SENSOR

XBT falls in the water at known speed

Calculating the time from launch to each data acquisition
we know the related depth

$$V=L/T$$



$$L=V*T$$

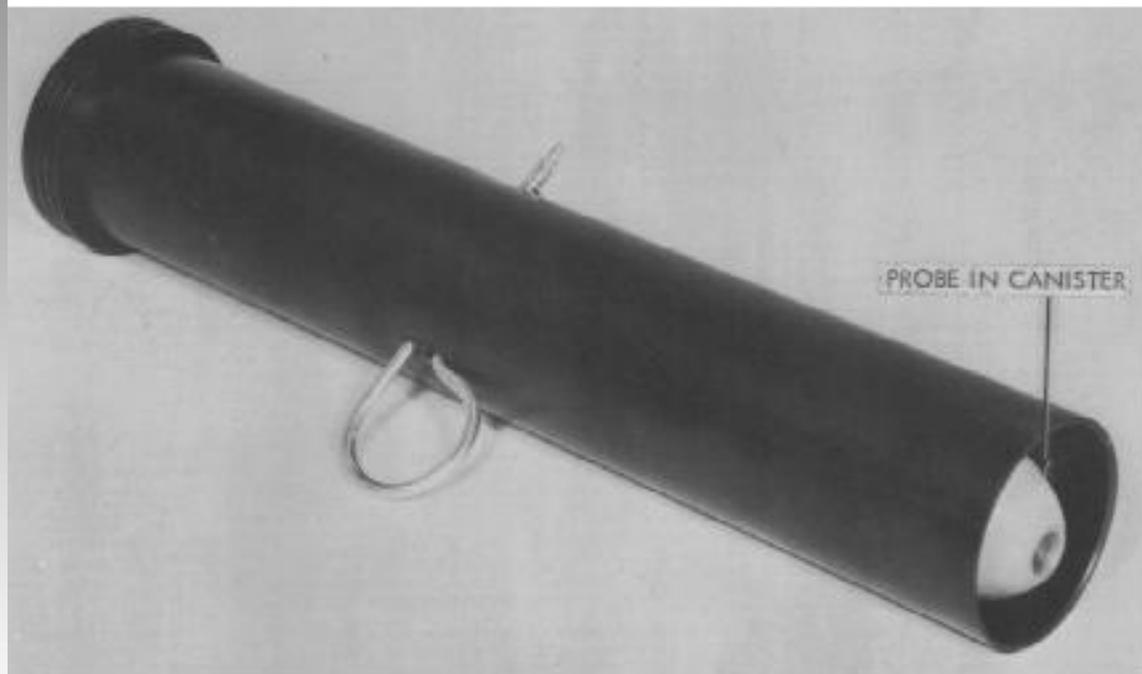
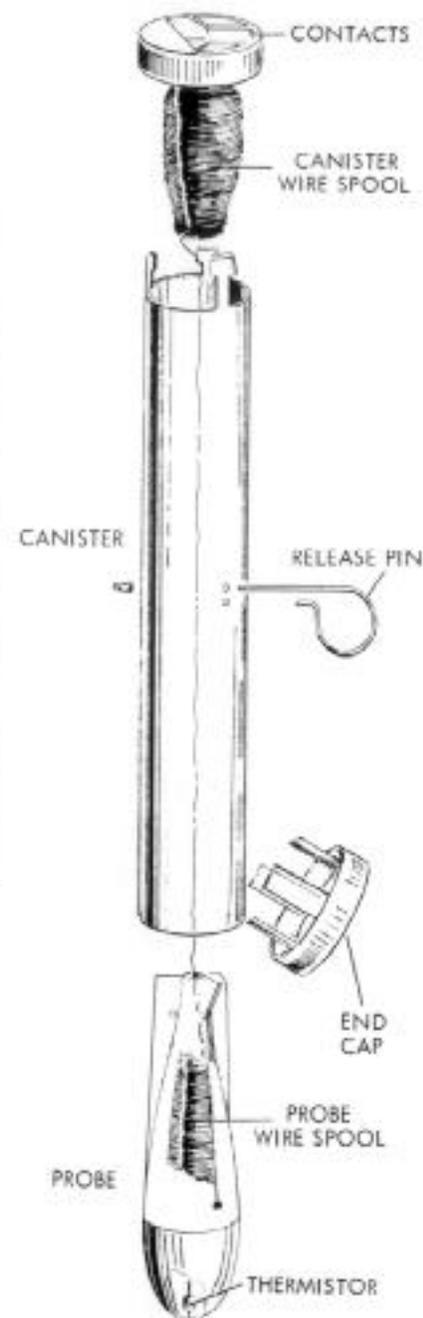
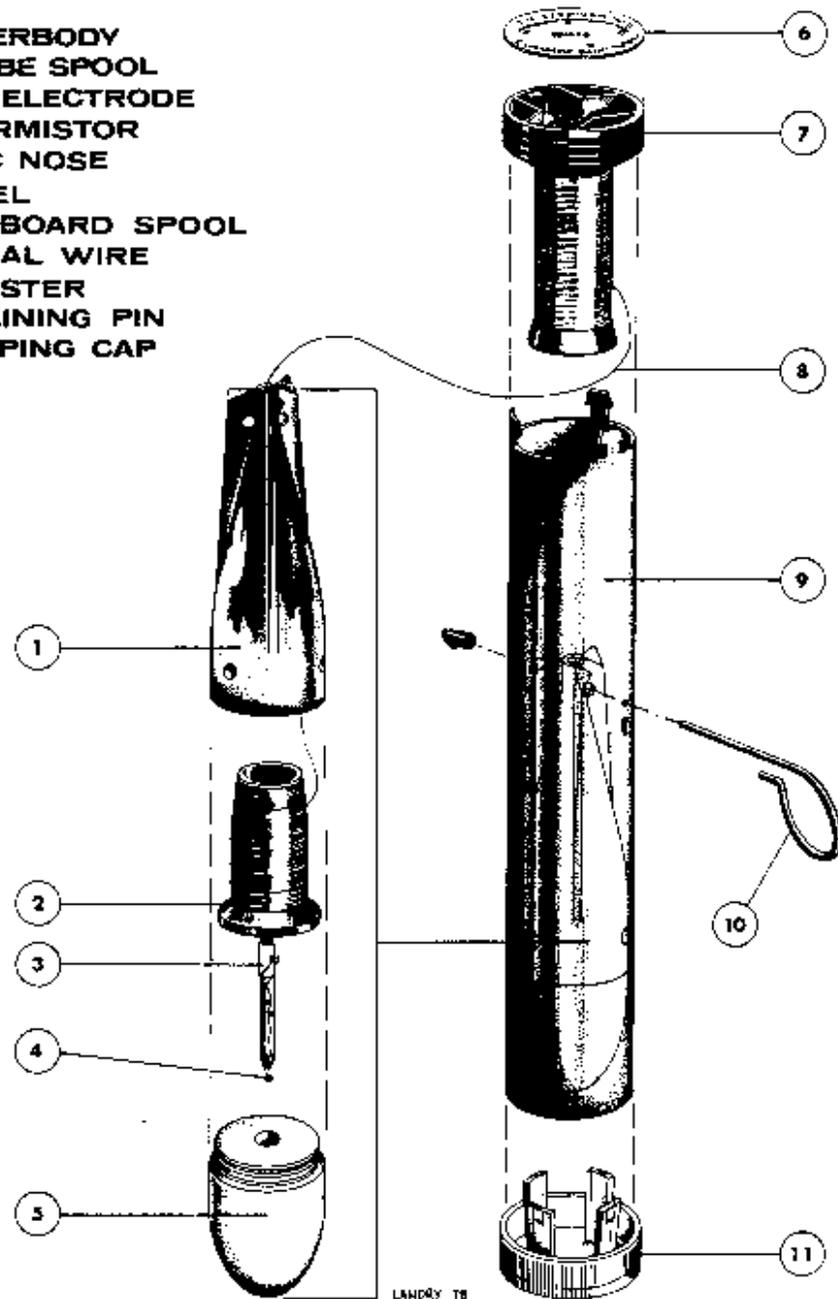


Fig. 1: XBT diagrams: Bathythermograph (probe) and exploded view.



XBT EXPLODED VIEW

- ① AFTERBODY
- ② PROBE SPOOL
- ③ SEA ELECTRODE
- ④ THERMISTOR
- ⑤ ZINC NOSE
- ⑥ LABEL
- ⑦ SHIPBOARD SPOOL
- ⑧ SIGNAL WIRE
- ⑨ CANISTER
- ⑩ RETAINING PIN
- ⑪ SHIPPING CAP



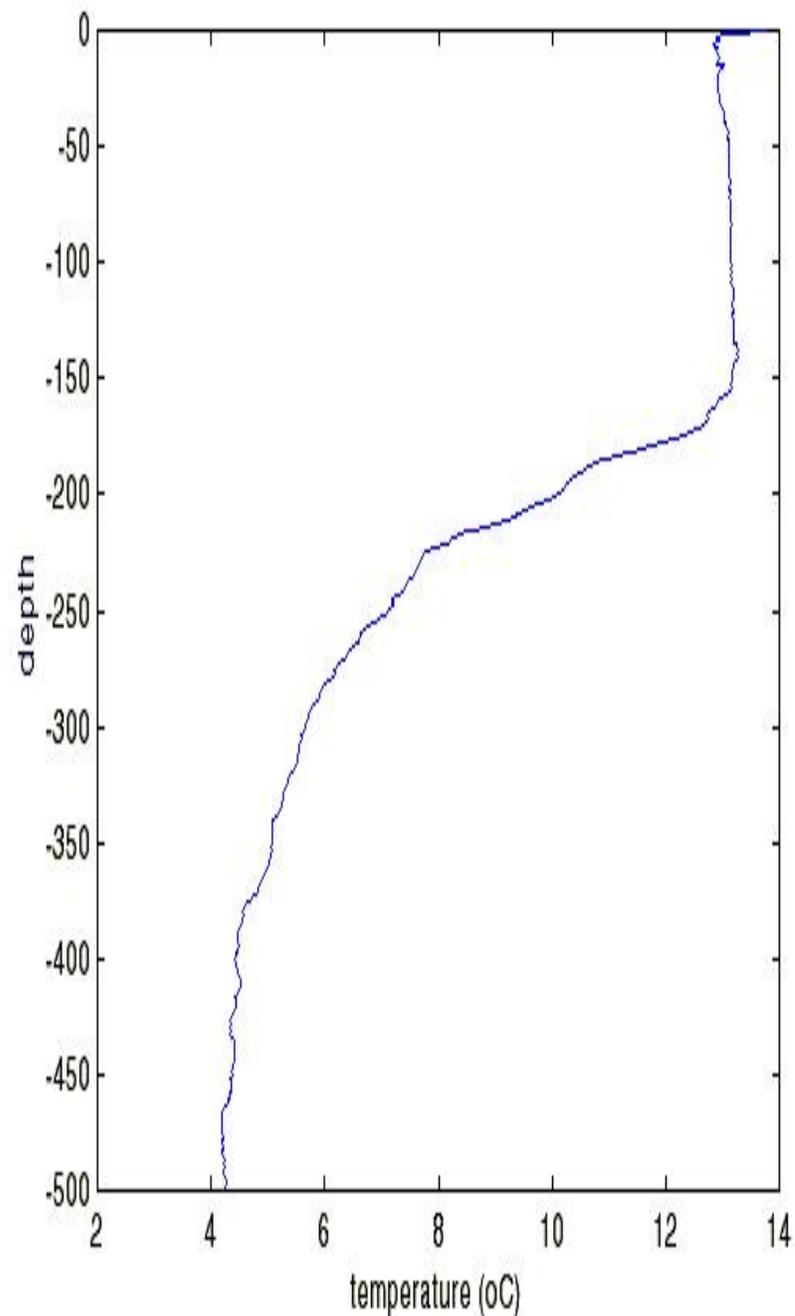


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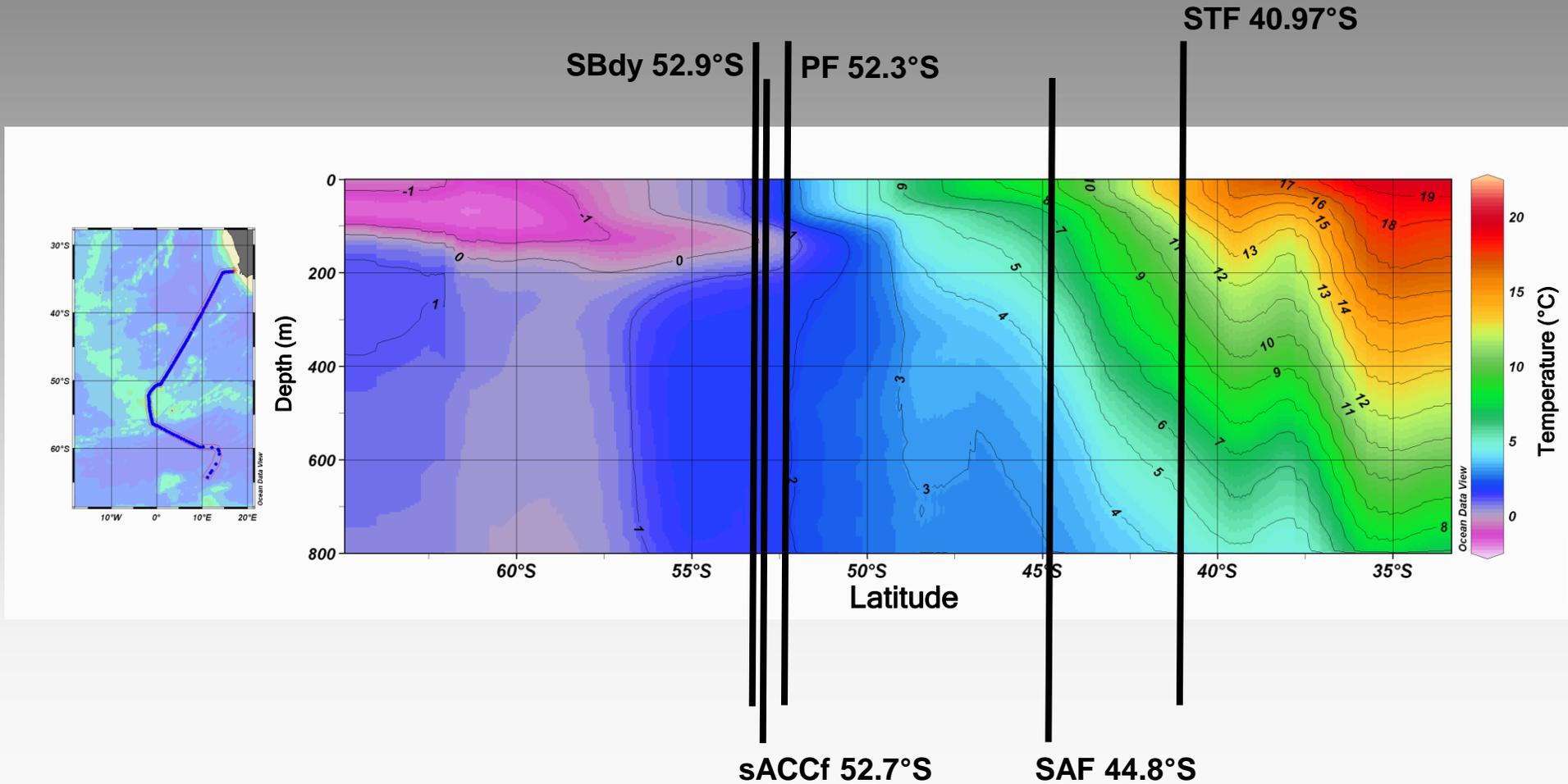
// This is an MK12 EXPORT DATA FILE (EDF)
//
Date of Launch : 01/07/00
Time of Launch : 09:36:00
Sequence # : 3
Latitude : 49 40 S
Longitude : 174 11 E
Serial # : 295074
DEPTH : 522
SHIP : italica
//
// Here are the contents of the memo fields.
//
// Here is some probe information for this drop
//
Probe Type : T-7
Terminal Depth : 760 m
Depth Coefficient 1 : .00216
Depth Coefficient 2 : 6.472
//
Raw Data Filename : T7$00003.RDF
//
Display Units : METRIC
//
// And here are the depth(M)/temperature(C) pairs.
//

```

1.9	10.07
2.5	10.04
3.2	10.05
3.8	10.05
4.5	10.05
5.1	10.05
5.8	10.05
6.4	10.05
7.1	10.05
7.7	10.05



XBT section from 9 to 21 December 2009



Front	Temperature criteria	Classical position (°S)
STF	$10^{\circ}\text{C} < \theta_{100\text{ m}} < 12^{\circ}\text{C}$	39.9
SAF	$\theta > 4\text{--}5^{\circ}\text{C}$ at 400 m, farther north	47.6
APF	$\theta < 2^{\circ}\text{C}$ along θ_{min} at $z < 200$ m, farther south	49.6
sACCF	$\theta < 0^{\circ}\text{C}$ along θ_{min} at $z < 150$ m, farther south	52.4
SBdy	Southern limit of vertical maximum of $\theta > 1.5^{\circ}\text{C}$, ($\sim 200\text{m}$)	56.1



The XBT is capable of temperature accuracies of $\pm 0.1^{\circ}\text{C}$.

Expendable Bathythermograph (XBT)

Applications		Maximum Depth	Rated Ship Speed*	Vertical Resolution
T-4	Standard probe used by the U.S. Navy for ASW operations.	460 m 1500 ft	30 knots	65 cm
T-5	Deep ocean scientific and military applications.	1830 m 6000 ft	6 knots	65 cm
Fast Deep™	Provides maximum depth capabilities at the highest possible ship speed of any XBT.	1000 m 3280 ft	20 knots	65 cm
T-6	Oceanographic applications.	460 m 1500 ft	15 knots	65 cm
T-7	Increased depth for improved sonar prediction in ASW and other military applications.	760 m 2500 ft	15 knots	65 cm
Deep Blue	Increased launch speed for oceanographic and naval applications.	760 m 2500 ft	20 knots	65 cm
T-10	Commercial fisheries applications.	200 m 600 ft	10 knots	65 cm
T-11 (Fine Structure)	High resolution for U.S. Navy mine counter-measures and physical oceanographic applications.	460 m 1500 ft	6 knots	18 cm



KE

XCTD

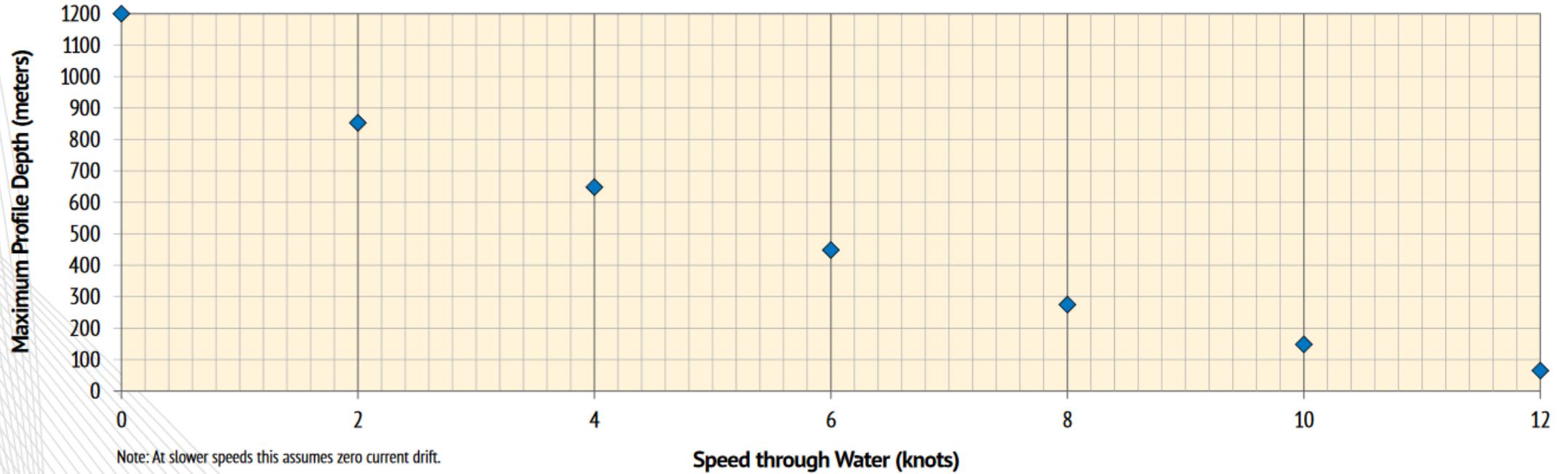


UNDERWAY CTD/RAPIDCAST





rapidCAST Depth vs Speed Table—RapidSV Probe
(call for details on other probes)



Moving Vessel Profiler





Photo courtesy of NOAA



Photo courtesy of Canadian Coast Guard

	MVP30		MVP30-350		MVP200		MVP300	
Speed (knots)	Depth Obtained (m)	Cycle Time (min.)						
0	125	2.6	350	8.5	600	12.9	3400	70
1	105	2.5	290	7.8	520	9.9	2683	61
2	90	2.3	245	7.5	457	8.4	2200	57
3	80	2.2	228	7.3	406	7.4	1900	55
4	73	2.1	200	7.0	368	6.9	1650	53
5	66	2.1	175	6.7	335	6.5	1450	50
6	60	2.0	155	6.4	310	6.4	1250	48
7	56	1.9	140	5.8	285	6.0	950	37
8	51	1.8	121	5.1	265	5.9	740	29
9	47	1.7	90	4.2	250	5.8	580	23
10	42	1.7	70	3.3	235	5.8	400	19
11	35	1.6	55	2.5	223	5.7	370	18
12	30	1.6	30	2.2	200	5.6	300	13
Dimensions w/o boom (m)	0.7 x 0.3		0.8 x 0.7		1.3 x 0.7		2.0 x 2.0	
Weight (kg)	120		140		760		1800	
System	Electrical		Electrical		Hydraulic		Hydraulic	
Power (hp)	1.5		1.5		15		25	
Cable	125m		350m		600m		3,400m	

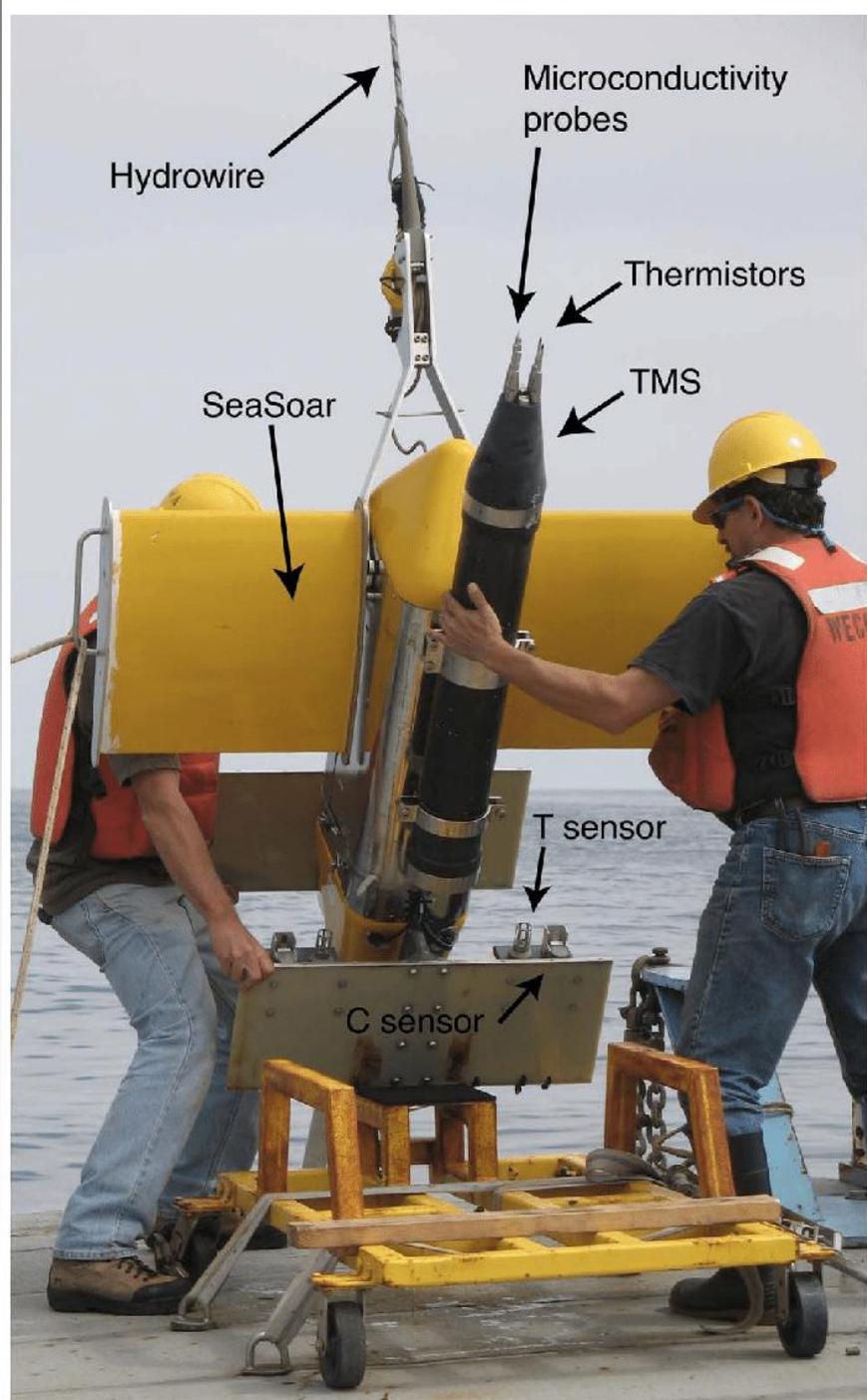


SeaSoar

The SeaSoar, manufactured by Chelsea Instruments, Ltd., is a towed vehicle equipped with impeller-forced wings that can be rotated to allow the vehicle to undulate in the upper ocean. The wings are controlled through the multi-conductor tow cable by sending current signals generated by a PC-based controller onboard ship to a hydraulic unit inside the vehicle. Typical instrumentation includes a SeaBird 911+ CTD with pressure and dual conductivity and temperature sensors, and optical instrumentation such as fluorometer, transmissometer, PAR sensor, an experimental bioluminescence sensor and others.

Under the original open-ocean configuration, SeaSoar undulates between the surface and about 400 meters depth while being towed on faired cable at about eight knots. A typical dive cycle takes about 12 minutes to complete, providing an up- and down profile every 3 km. We obtained more frequent sampling during our shallow water experiments (PRIMER, GLOBEC), where a complete dive cycle down to 100 meters takes on average three minutes, providing a horizontal resolution of about 400 meters at mid-depth.







THANKS!

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
(D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-
Mission 4 “Education and Research” - Component 2: “From research to business” - Investment
3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures”

