JERICO

JOINT EUROPEAN RESEARCH INFRASTRUCTURE NETWORK FOR COASTAL OBSERVATORIES

BIOFOULING PROTECTION FOR OCEANOGRAPHIC SENSORS

Best Practices Workshop

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We are playing in an *In Situ* marine context !

A tough medium... isn't it ?

Coastal monitoring

Three months maintenance

A matter of energy and accessibility

Cabled energy

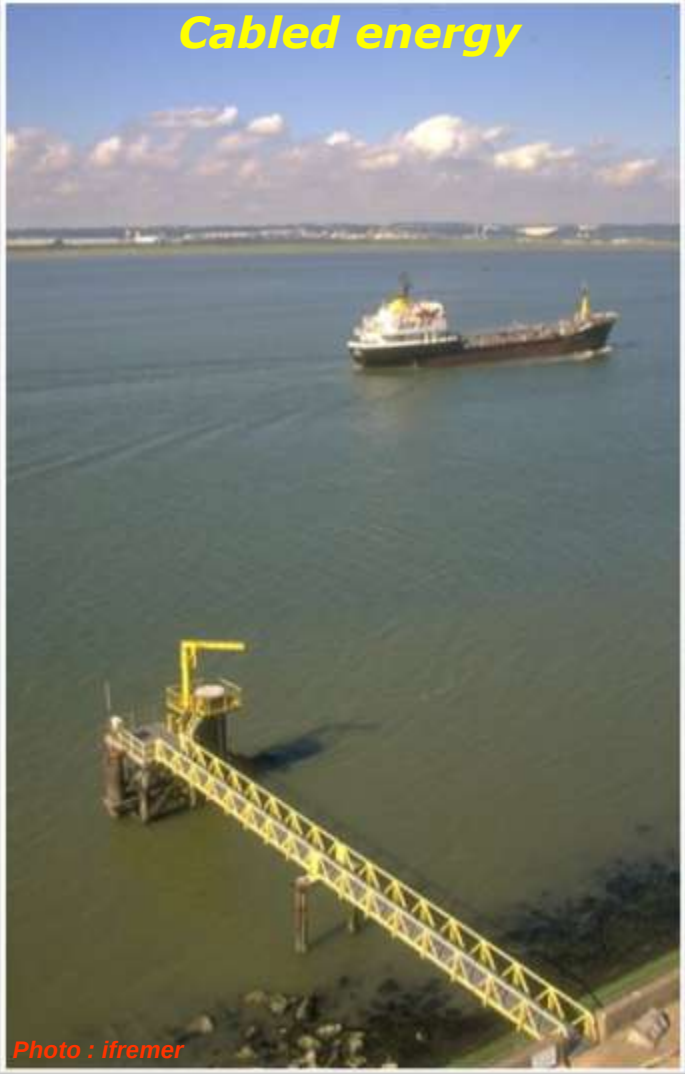


Photo : ifremer

Solar Energy

Photo : ifremer

Coastal monitoring

Three months maintenance

A matter of energy and accessibility

Wind flow Energy

Photo : Ifremer (FR)

Coastal Monitoring

Three months maintenance

A matter of energy and accessibility

Photo : Ifremer (FR)

Photo : Ifremer (FR)

Coastal Monitoring

Three months maintenance

Seafloor observatories in Europe

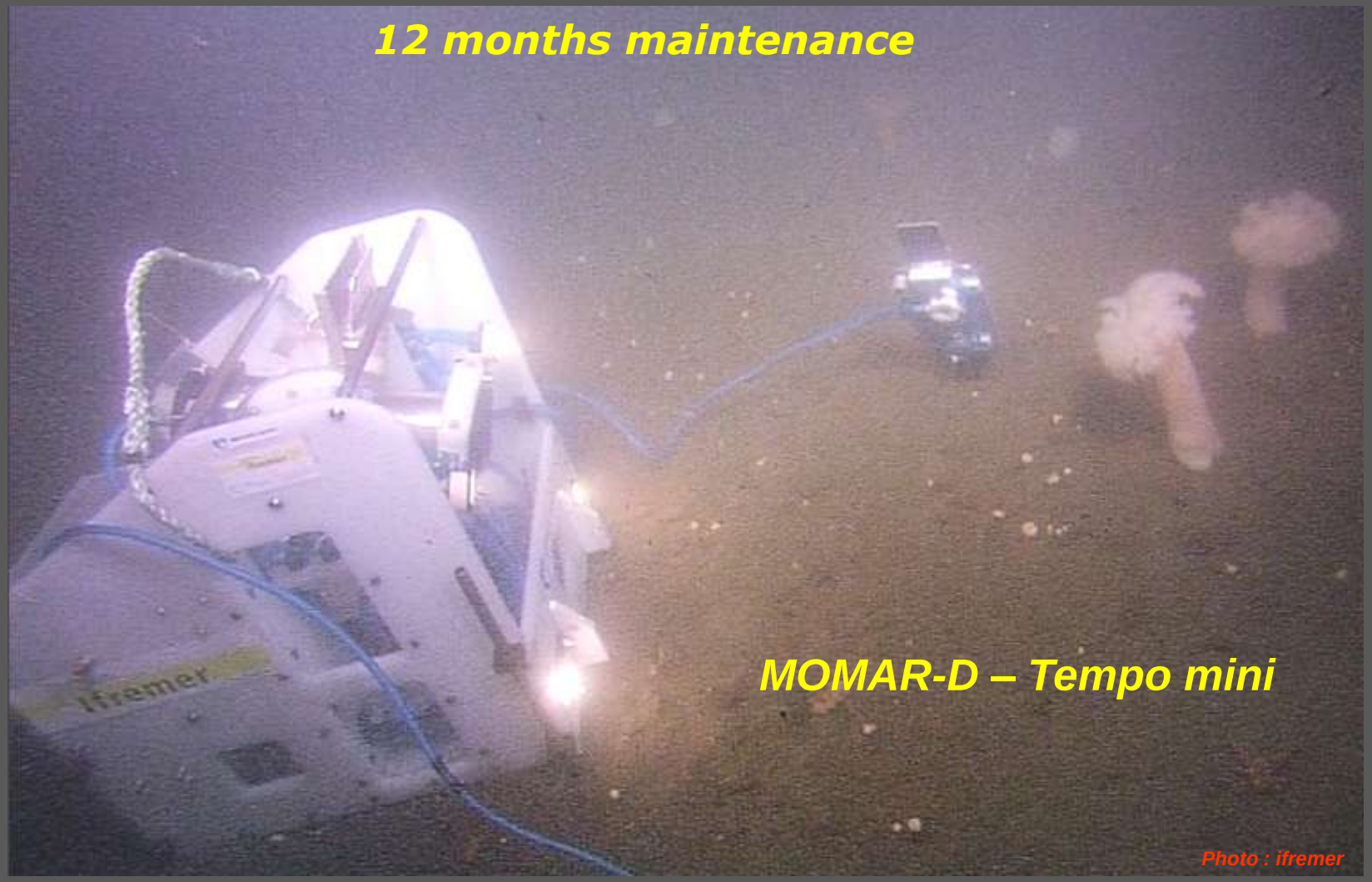
Azores seafloor observatory

1700m deep, hydrothermales sources

Energy provided by batteries

A matter of energy and accessibility

12 months maintenance



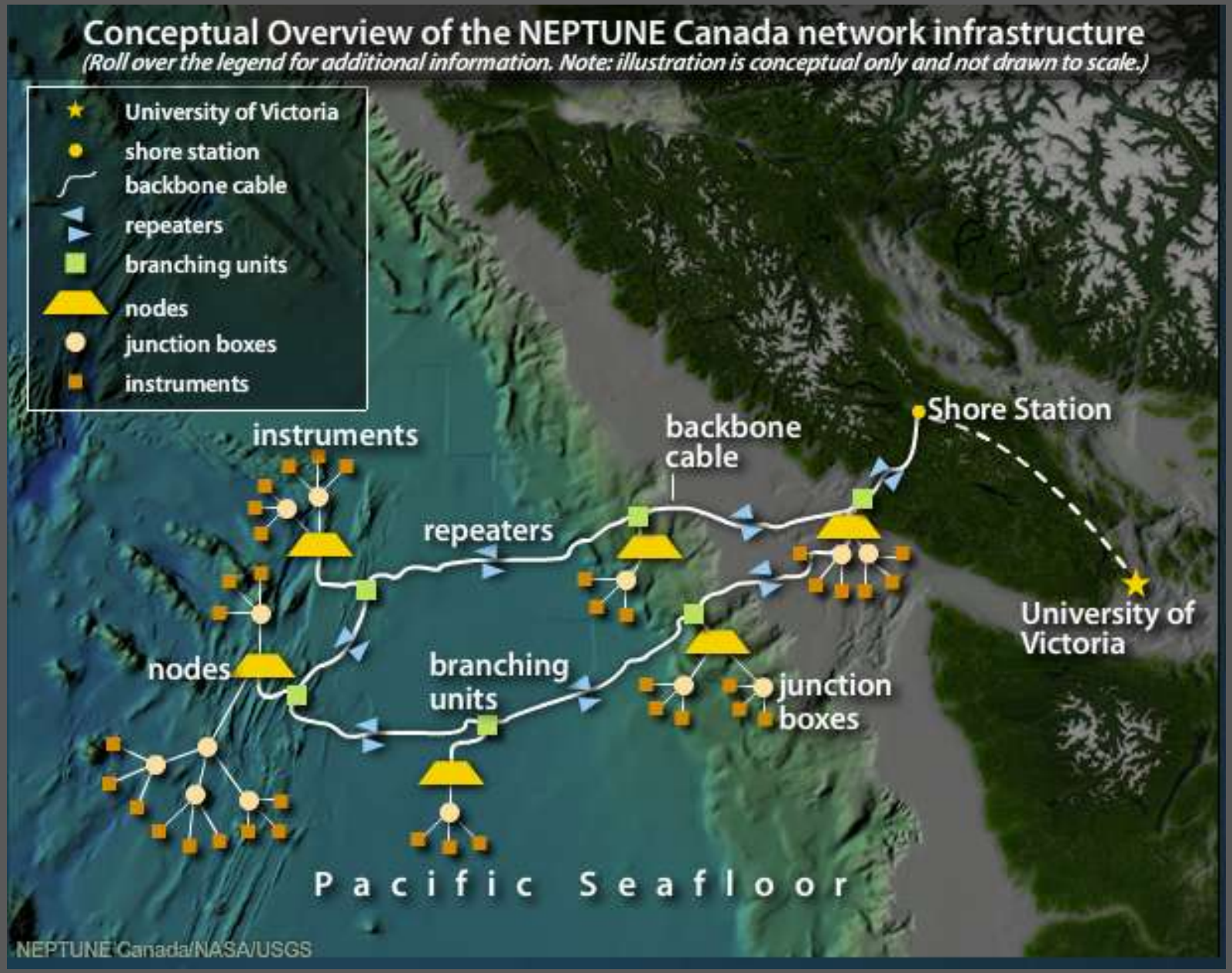
MOMAR-D – Tempo mini

Photo : ifremer

NEPTUNE Canada Seafloor Observatory

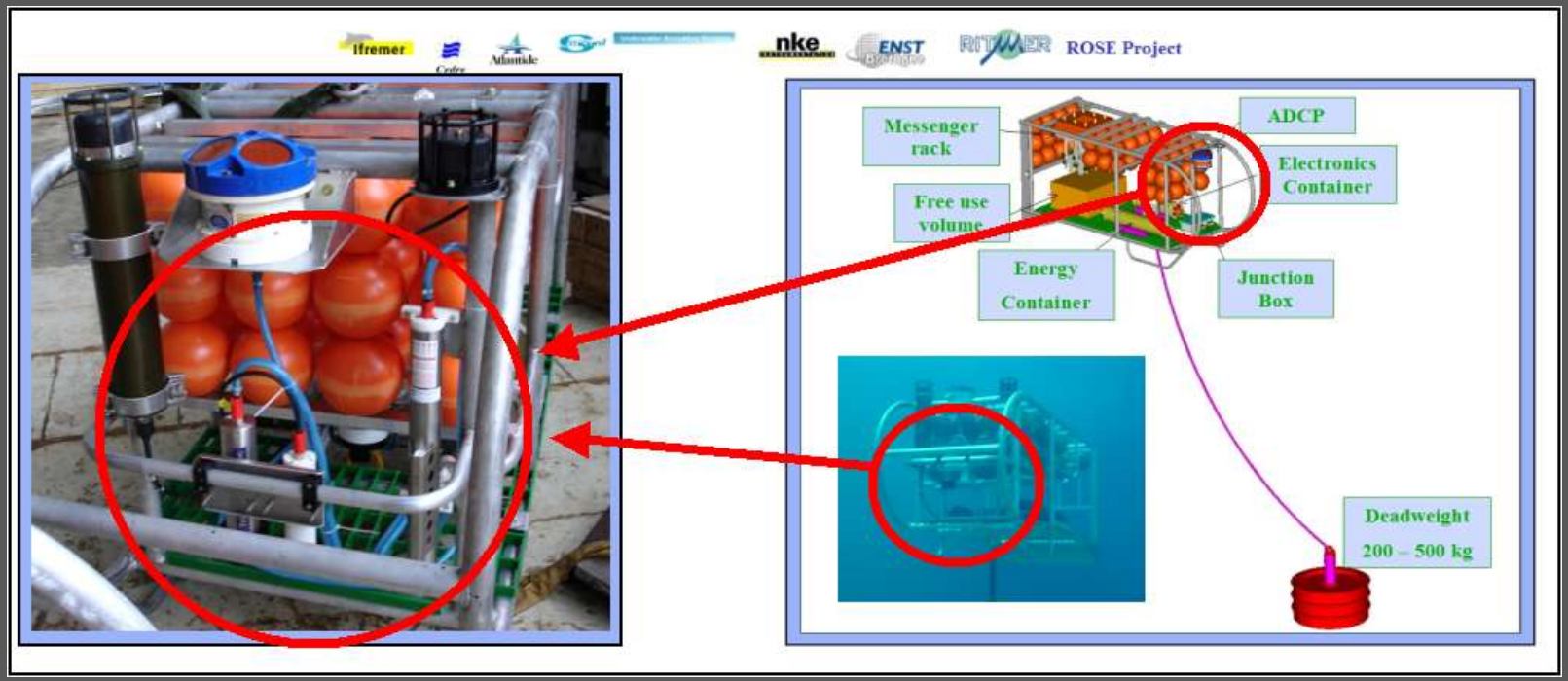
800 km – 40 to 2500m deep

Maintenance every 6 months, Cabled energy but limited !



Marine Benthic Observatories for HC leaks detection.

- Various depth (from 15 meters down to whatever needed)
- Long term monitoring (more than 1 month)
- Low maintenance (In fact, No maintenance)



- Oceanographic sensor are involved (ROSE Project) :
  - Hydrocarbon fluorometer : Trios EnviroFlu-HC (*)
  - 2 Turbidity Meters : WET labs BBRTD-226R / D&A OBS 3
  - O2 Optode Sensor : Aanderaa 3830 (+ temperature)
  - CTD : SBE 37SMP
  - ADCP : RDI 300 kHz

Floats

Very low energy available, NO maintenance

(3 years deployement)

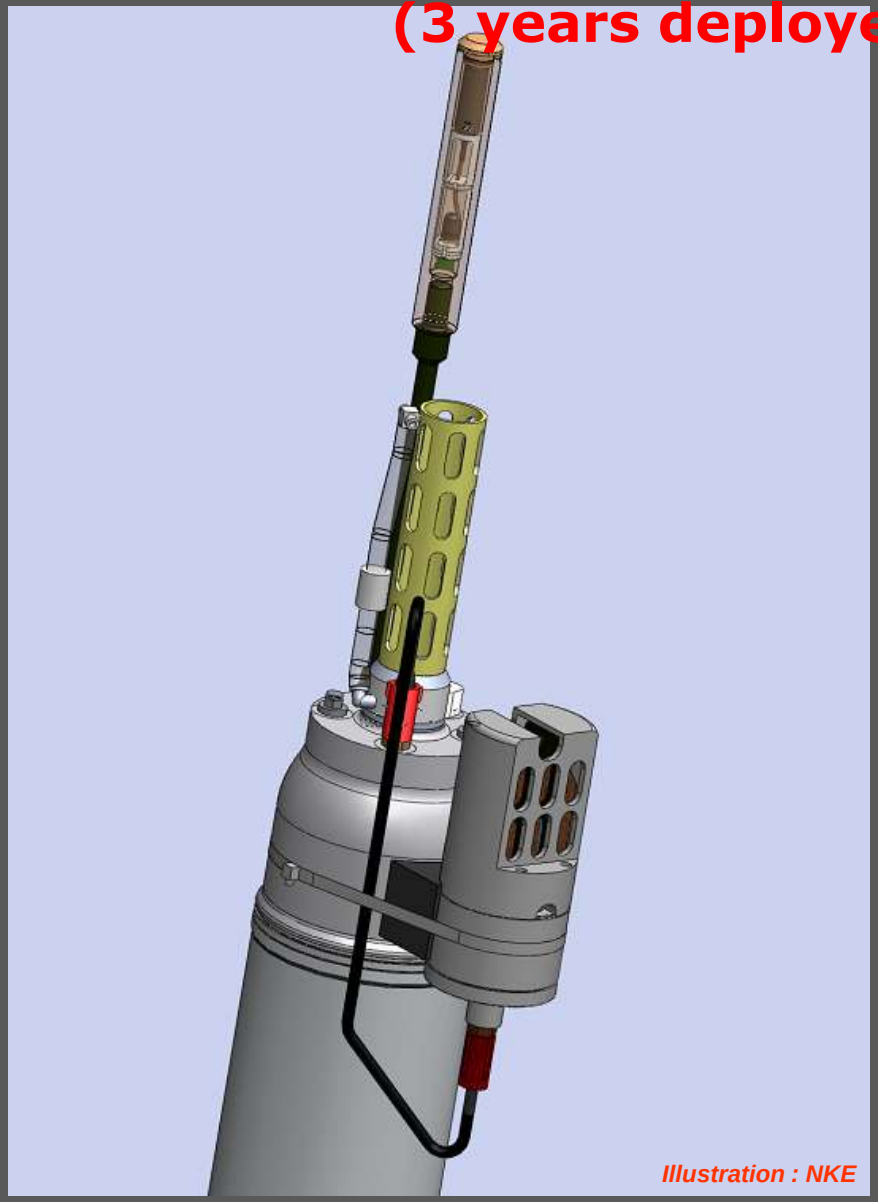


Illustration : NKE

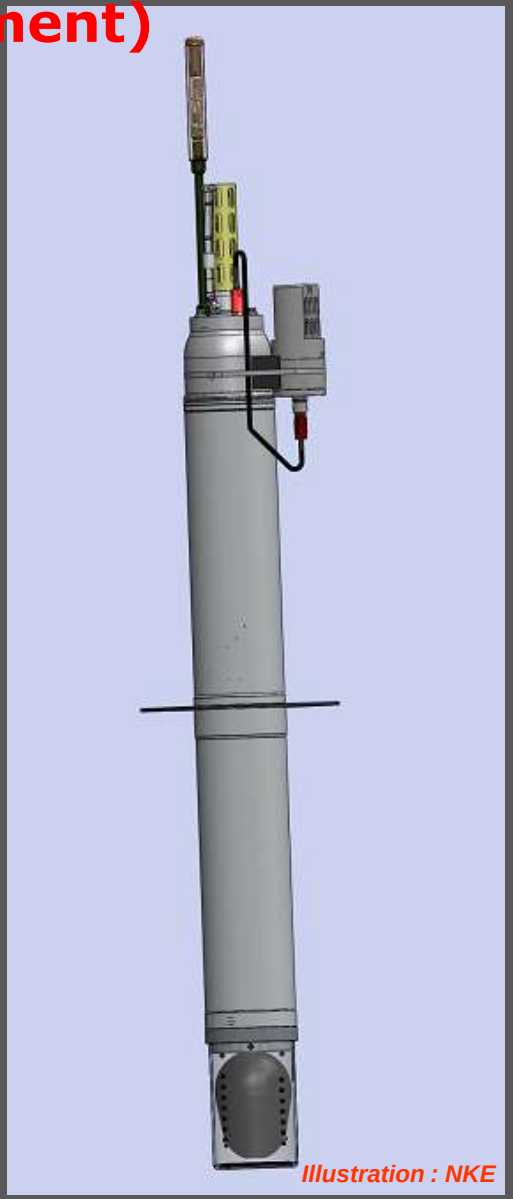


Illustration : NKE

Projet NOSS : NKE, Telecom Bretagne, SHOM, ifremer

Gliders

Very low energy, no maintenance

Few days deployment (usually)

Photo : Site internet ACSA

Scientific drones – USV Mobesens

Low Energy, No maintenance

One day deployment

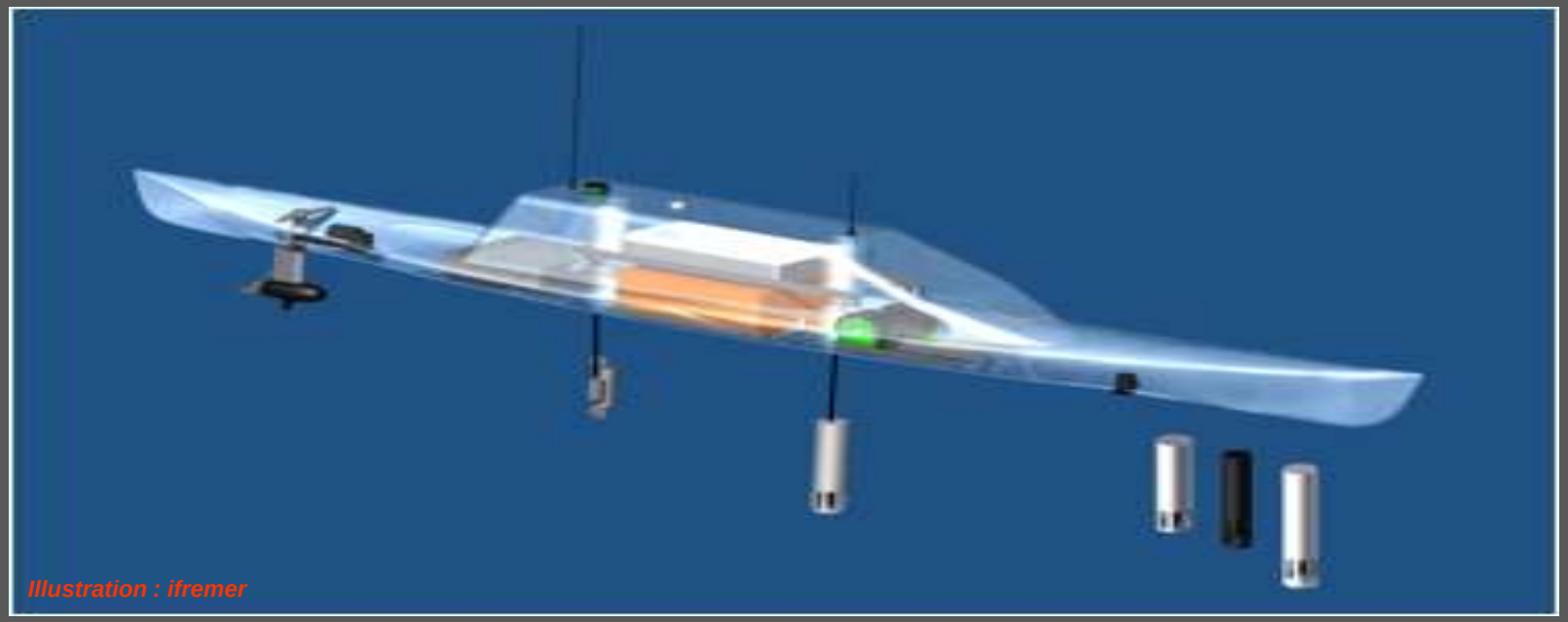
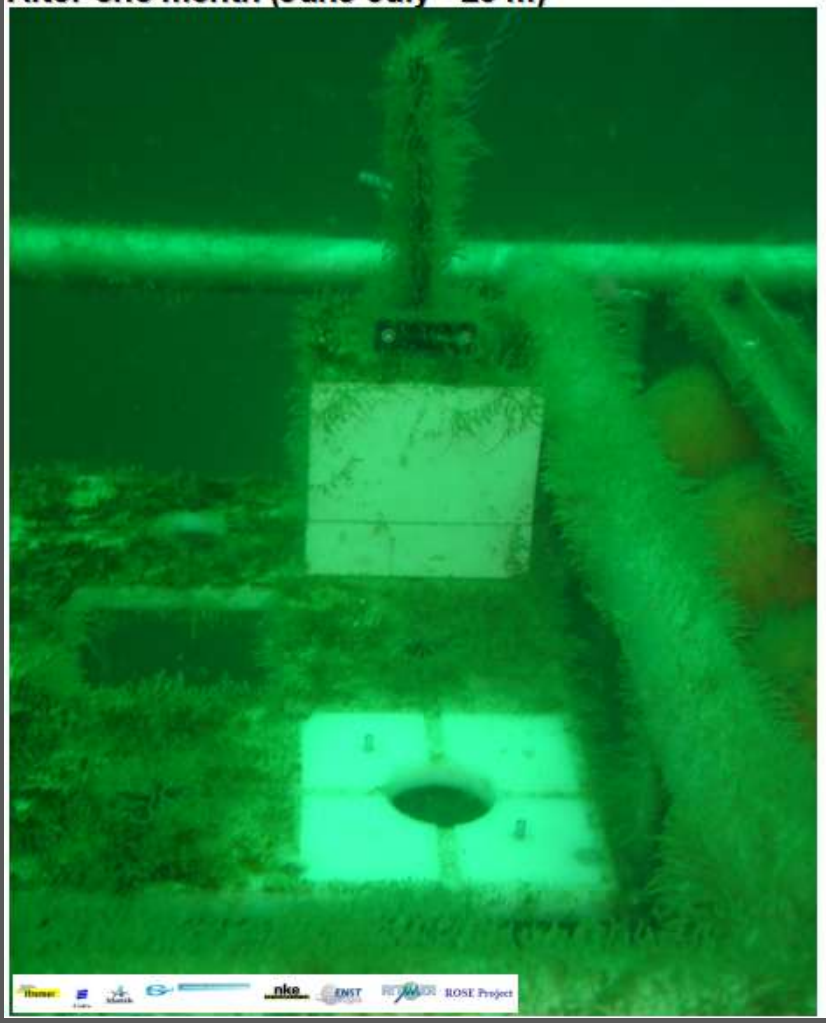


Illustration : ifremer

Sensors and biofouling

Marine Benthic Observatories.

After one month (June-July - 25 m)



After three months (June-Sept. - 25 m)

Photos : Ifremer (FR)

Biofilm development must be taken into acount ...

Biofouling example

YSI 6600 EDS (Extended Deployment System) - Clean SweepTM

150 days ◆ April - Sept 2005 ◆ St Anne Portzic Brest

Photo : Ifremer (FR) L. Delauney

Biofouling example

YSI 6600 EDS (Extended Deployment System) - Clean SweepTM

150 days ◆ April - Sept 2005 ◆ St Anne Portzic Brest

Photo : Ifremer (FR) L. Delauney

Biofouling example

Optisens Transmissometer

90 days ◆ August - October 2005 ◆ Trondheim

Photo : Ifremer (FR) L. Delauney

Biofouling example

Seapoint Fluorometer

90 days ◆ May - July 2006 ◆ Brest

Photo : Ifremer (FR) L. Delauney

Biofouling example

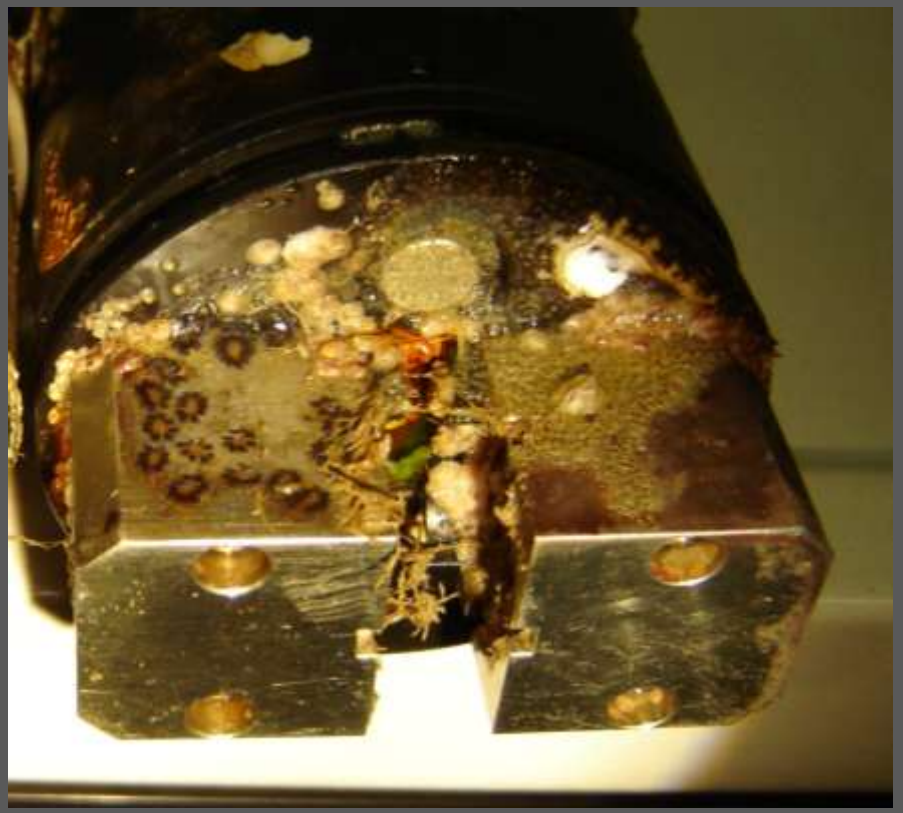
70 days ◆ June - August 2005 ◆ Helgoland - DE

Ifremer (FR) L. Delauney Y. Faijan
GKSS (DE) K. Kröeger et Al. - CNRS UPR15 (FR) H. Cachet et Al.

Biofouling example

- *Materials and shape shoud be choosed very carefully in order to reduce fouling attachement.*

40 days ◆ August - October 2005 ◆ Helgoland - DE



Photos : Ifremer (FR) L. Delauney

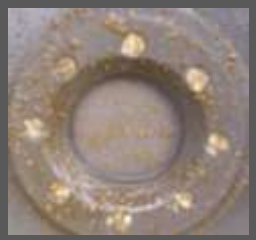
Biofouling effect on marine sensors : Progressive interface modification.

- Optical sensors : turbidimeter, fluorometer, ...,

  => optical property modification
  (Window opacity, interferences, ...

Atlantic Ocean

Bosphorus strait

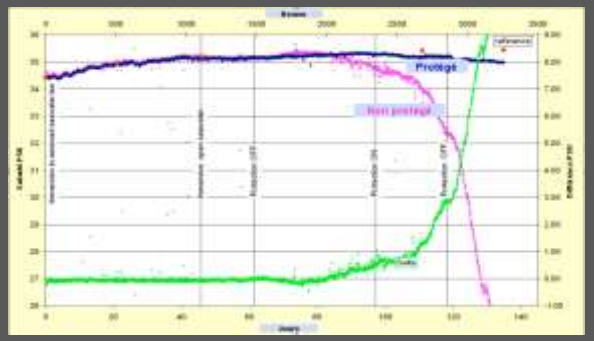


Baltic sea

- Membrane based sensors : pH, oxygen.

  => membrane permeability modifications.

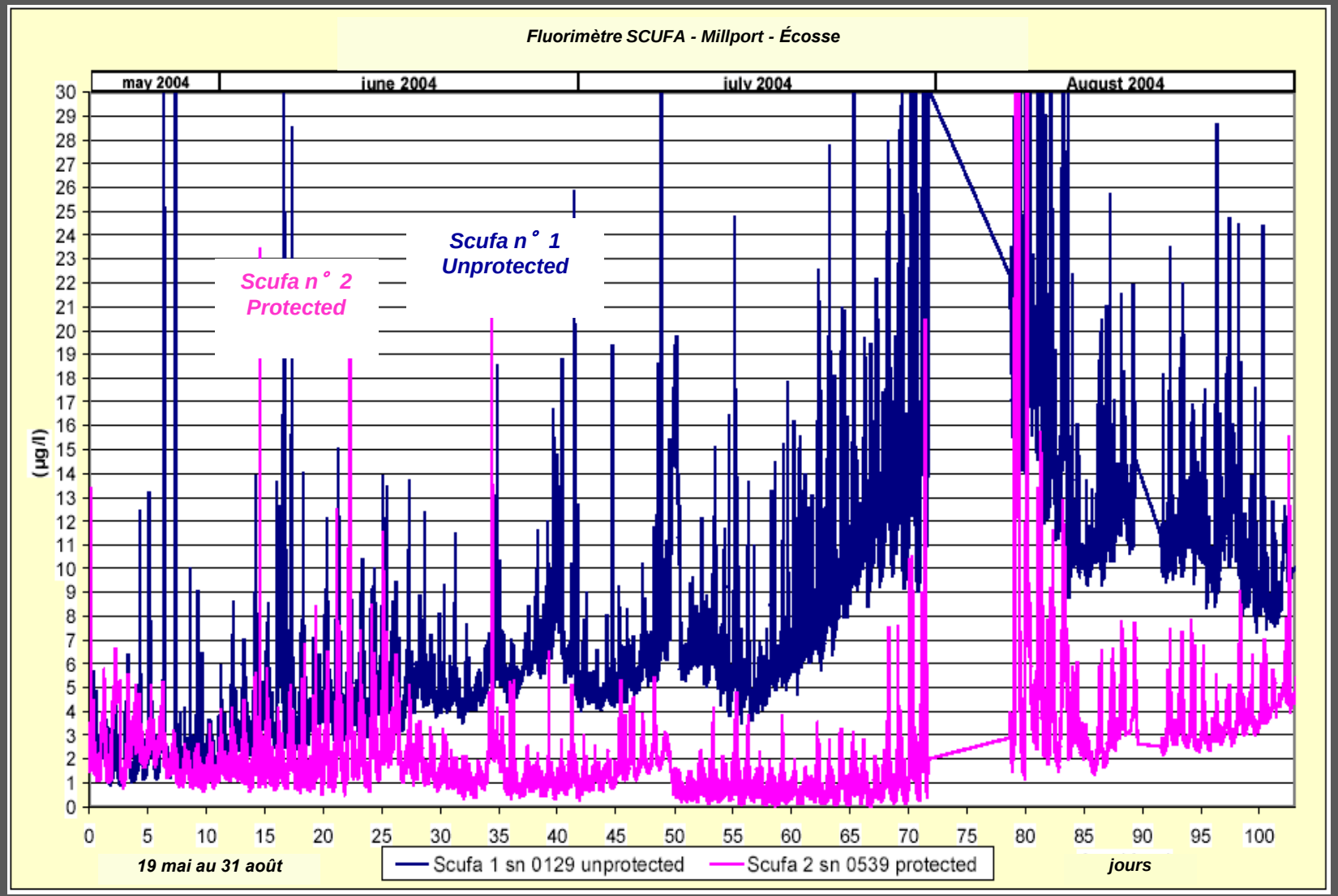
Loss of sensibility,
drift,
response time, etc.



This problem must be treated as long as autonomous measurement longer than 1 week is involved.

Biofouling effect on an in-situ Fluorometer

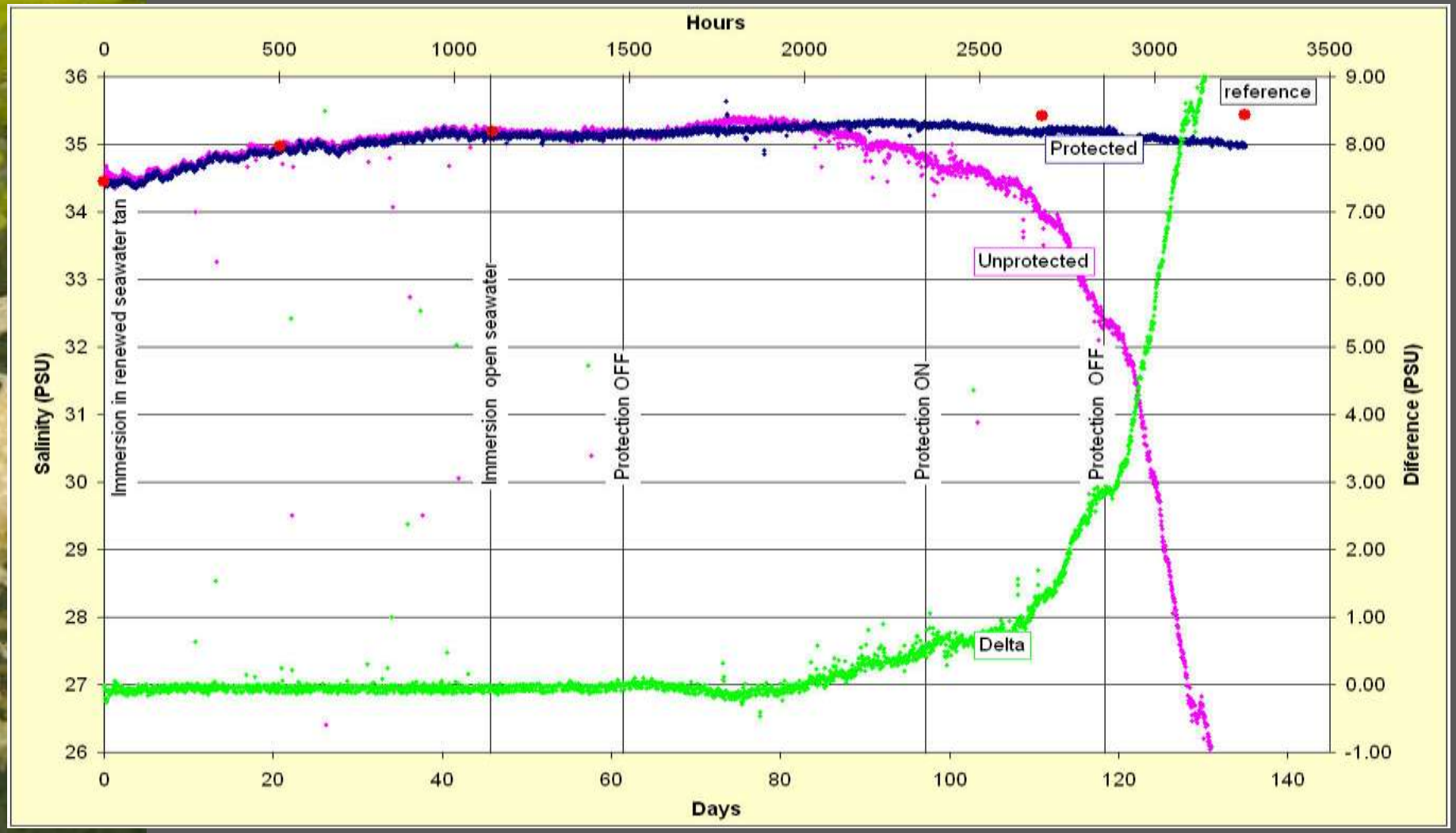
100 days ◆ 19 may - 31 August ◆ Millport



Ifremer (FR) Delauney, V.Lepage - UMBSM (UK) Dr P. Cowlie

Sensor deviation example : conductivity

133 days ◆ 03 June - 16 October 2003 ◆ St Anne Portzic Brest



Conductivity Measurement - TPS35 Micrel Instrument

Objectifs

- *The protection system must delay the biofouling effect on the response of the measuring system for at least 1 month in severe conditions and for 3 months in average condition.*

  For specific applications like deep sea observatories, biofouling protection effect should last for at least 6 months.

- *The protection system should be compatible with autonomous energy supplying (batteries).*

- *The protection system must be adaptable quite easily on existing instrumentation.*

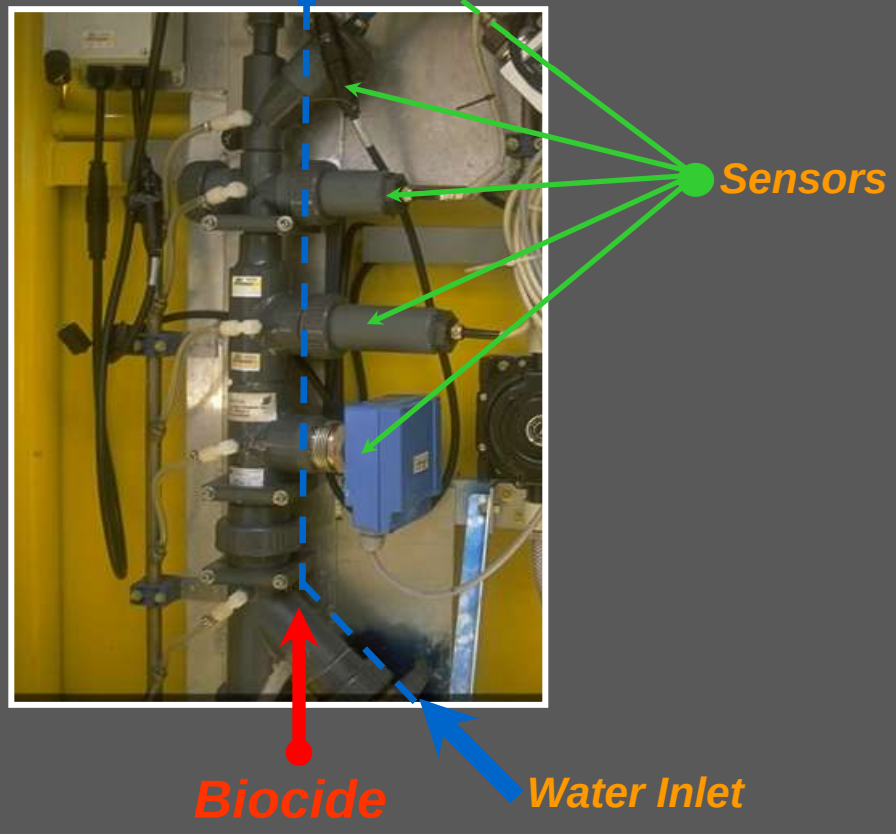
- *The protection system must not affect the measurements produced.*

Protection strategy

To be closer as possible
to the
transduction interface

Global Protection

- Pumping is needed



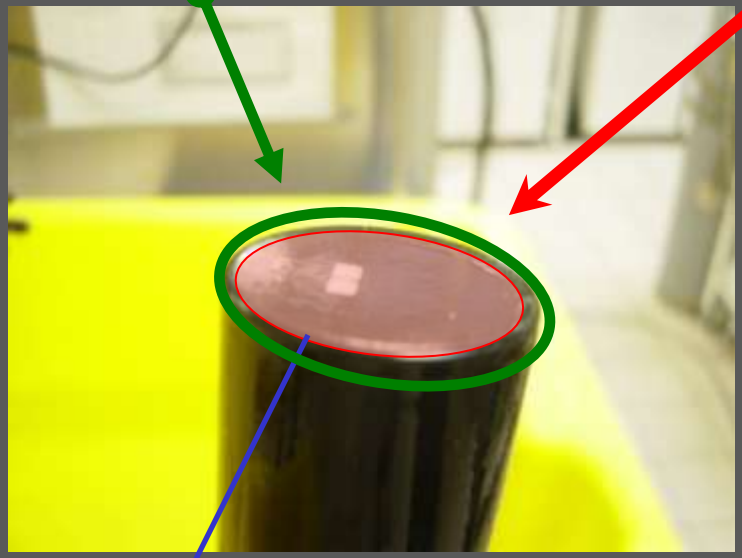
Photos : Ifremer (FR)

MAREL - Ifremer
Mesures Automatisées pour l'environnement littoral
(Autonomous Measurement for Coastal Environment)

Local Protection

Sensor Head

Biocide zone



- Pumping system not needed
- Biocide is produced as close as possible of the sensing element of the instrument.

Turbidimeter TBD 35 - NKE

Coated window Protection

Interface Modification

Glass window coated with a specific material in order to generate biocide on the surface (Work in progress)

Sensor transducing interface

Biocide zone

TriOS microFlu-chl

- ***Optical sensor, camera, lights, ...***
- ***Biocide generation is situated on the window surface.***
- ***Biocide quantity needed is very low.***

Existing biofouling protection for optical oceanographic sensors and conductivity sensors

Mechanical Protection

YSI 6600 EDS (Extended Deployment System) - Clean SweepTM

Mechanical Protection

ZEBRA-TECH (NZ) – Hydro Wiper

Photos courtesy of MScience Pty Ltd, Australia

Photo courtesy of USGS, Santa Cruz

Photo courtesy of NIWA, New Zealand

Photos : Zebra-Tech Web Site

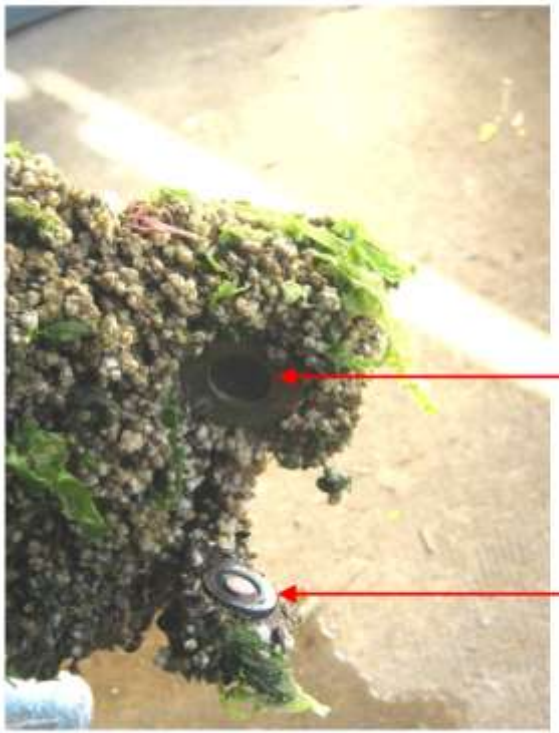
Mechanical Protection

ZEBRA-TECH (NZ) – Opto Shutter

D-Opto dissolved oxygen sensor with Shutter fitted

Shutter closed

Shutter open



Shutter open

Photos : Zebra-Tech Web Site

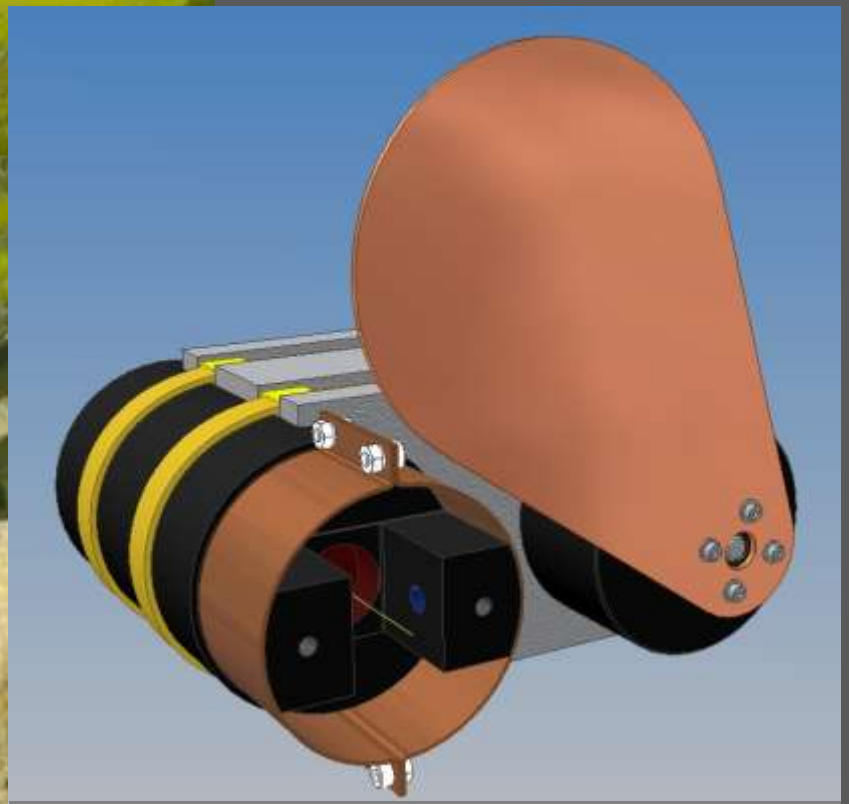
Mechanical Protection

ZEBRA-TECH (NZ) – Opto Shutter

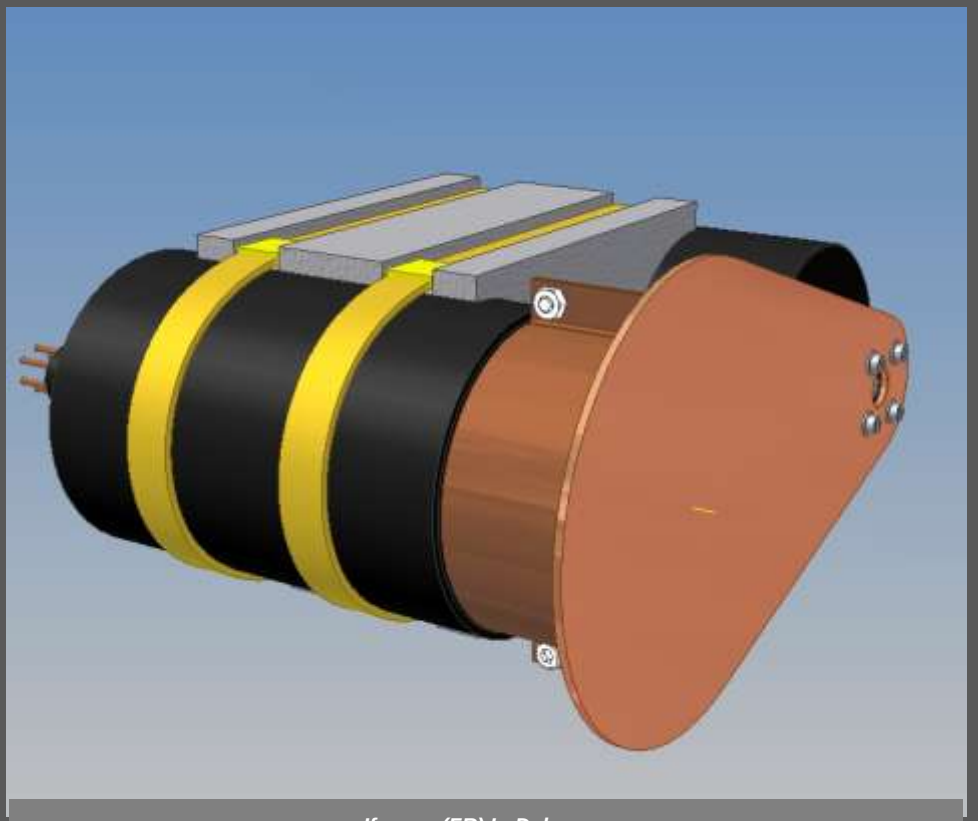
Film : Courtesy of NORTEKMED

Copper Biofouling protection

Fluorimeter Seapoint + Hobilabs Hydroshutter



Ifremer (FR) L. Delauney



Ifremer (FR) L. Delauney

- ***The instrument must be customised in order to build a Copper cell.***
- ***The Hydroshutter must be controlled by an external unit in order to open and to close it.***

Copper Biofouling protection

Fluorimeter Seapoint + Hobilabs Hydroshutter

Ifremer (FR) L. Delauney

Biocide diffusion tablet

Seabird conductivity sensor => TBT

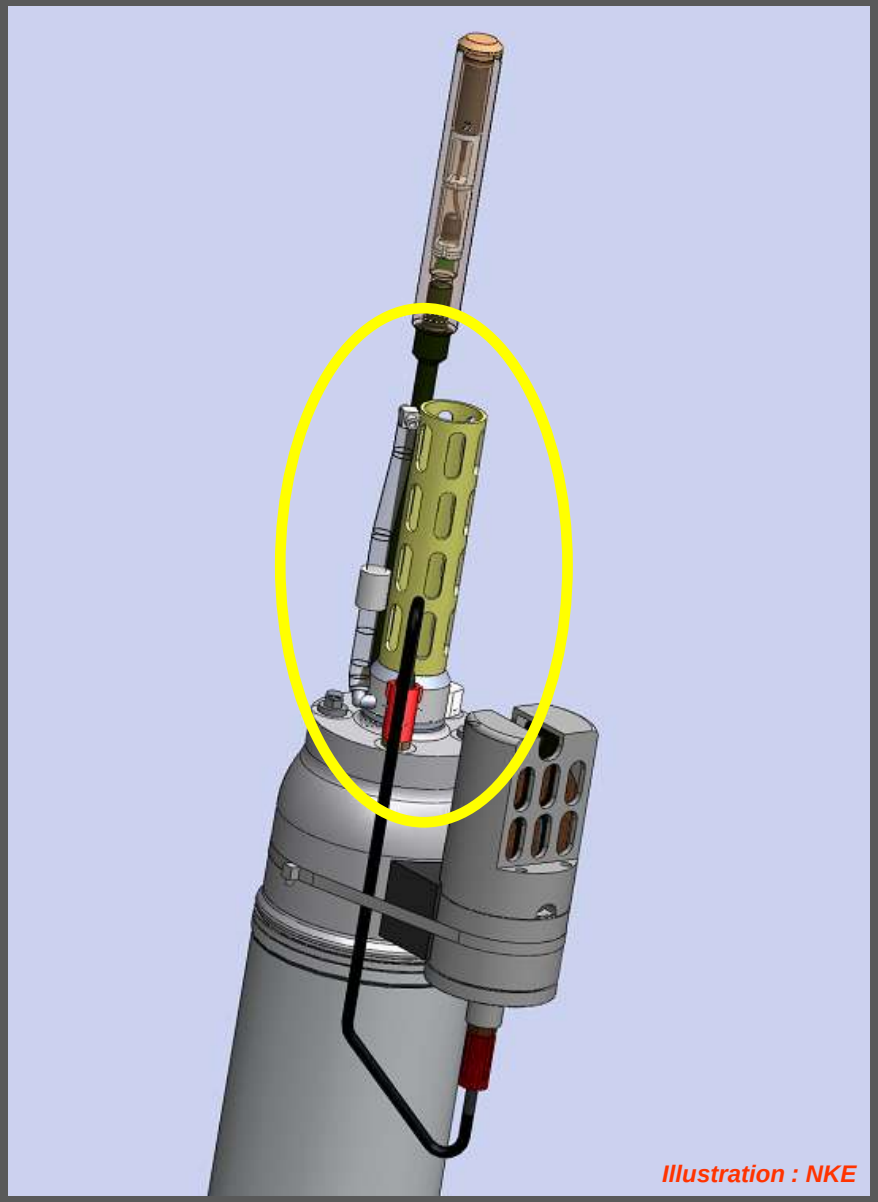


Illustration : NKE

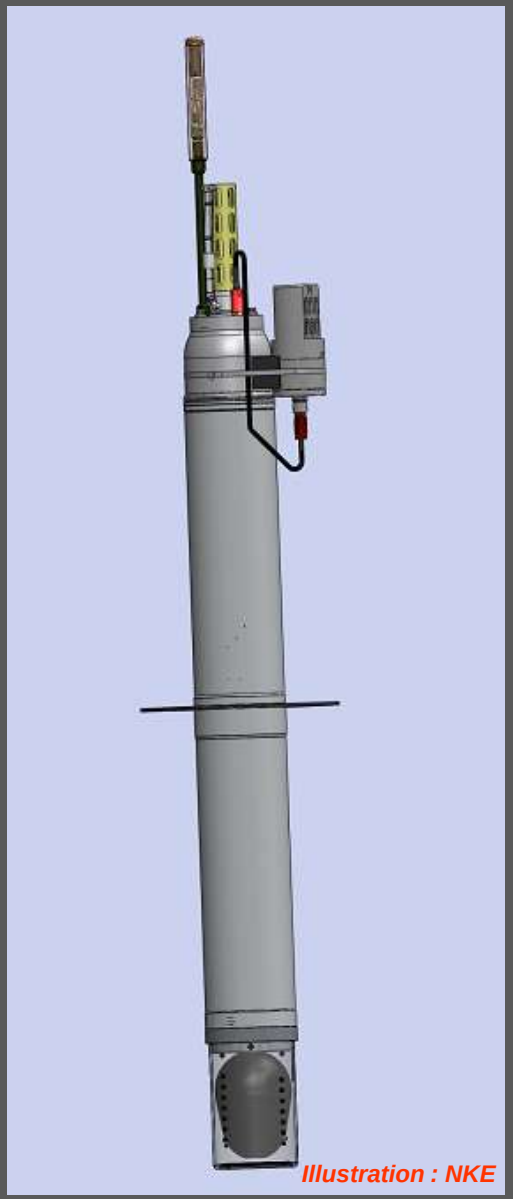


Illustration : NKE

Projet NOSS : NKE, Telecom Bretagne, SHOM, ifremer

Coated window Protection

Trios – Nano coating on windows

- high sensitivity
- wide operation range
- nano coated windows against fouling
- fast acquisition
- electronic daylight compensation
- miniaturized design
- low power consumption
- low cost
- easy to handle
- RS232 interface
- fully RS232 controllable
- 0..5V analog output
- Windows software for PC access
- controllable with handheld or TriBox2

TriOS
Optical Sensors

Nano Coating spray

YSI - Anti-fouling C-Spray Protective Probe Solution

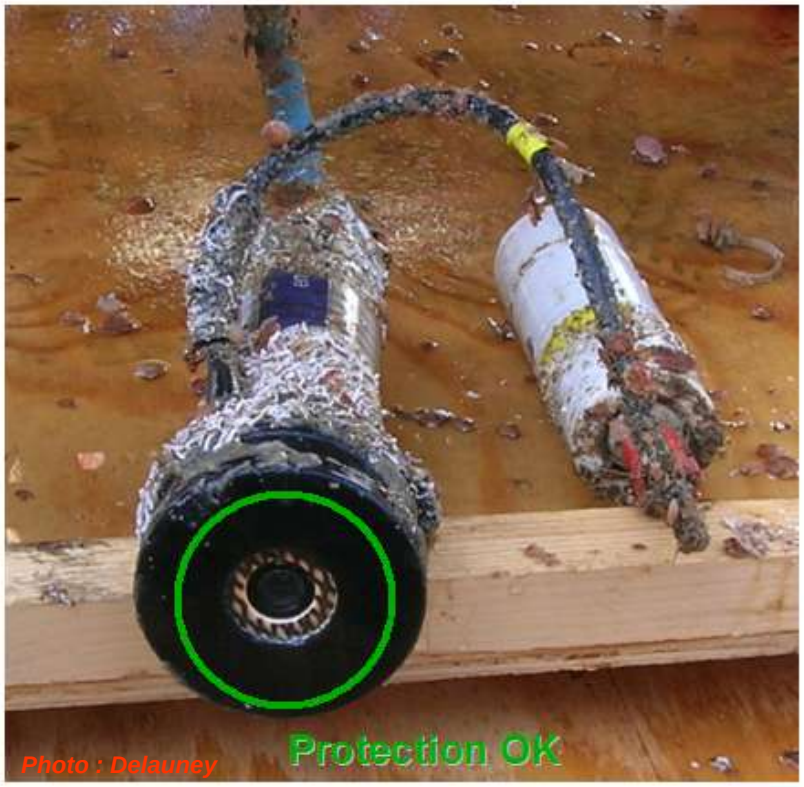
Biofouling protection

Local chlorination (ifremer)

Small windows protection

ROSE Experiment results
Benthic station – June to September 2006 - 25 meters deep

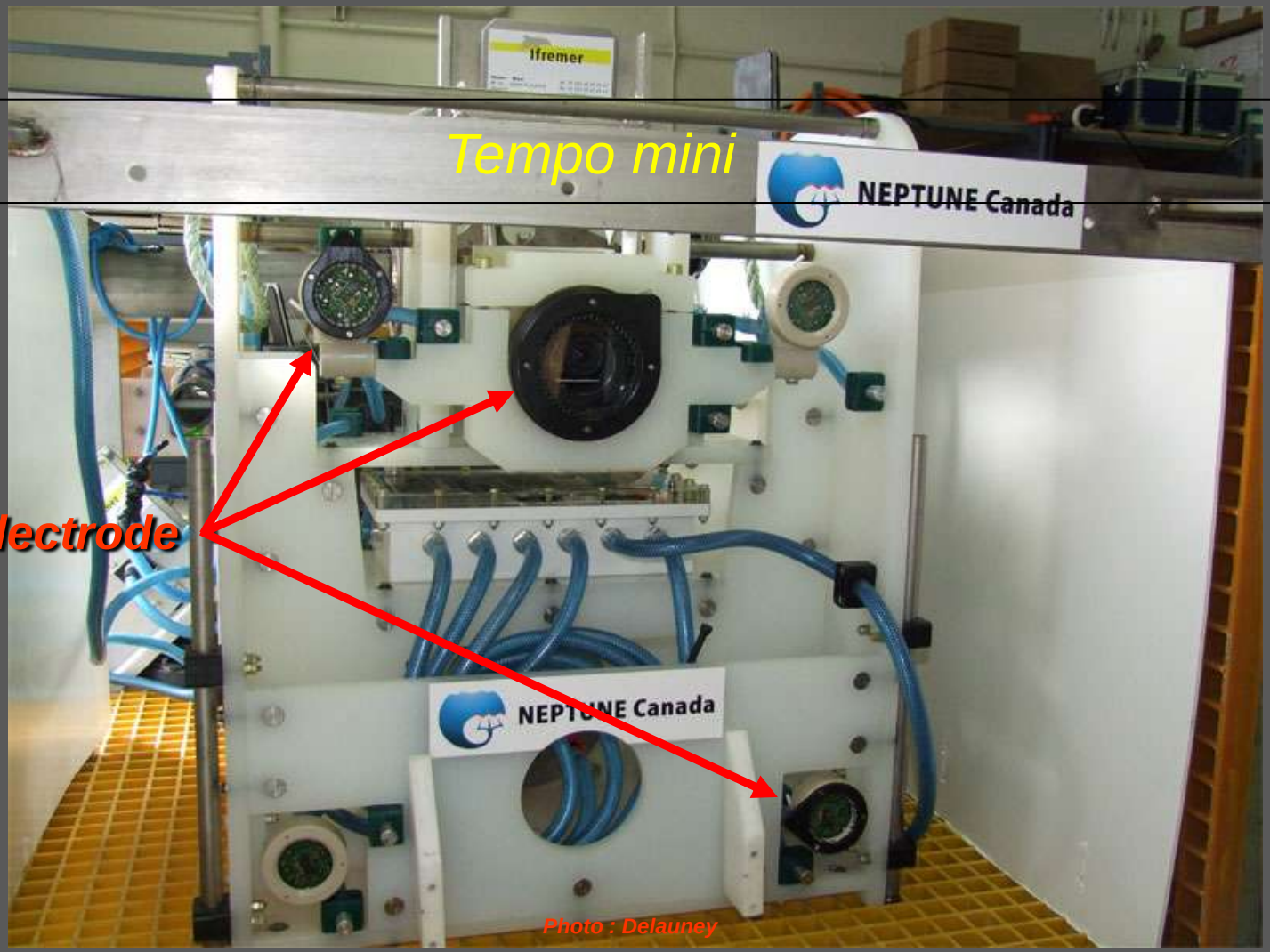
- *Hydrocarbon fluorometer : Trios EnviroFlu-HC*



Biofouling protection

Local chlorination (ifremer)

Large windows protection



Electro chlorination by Coated window Protection

40 days ◆ August - October 2005 ◆ Helgoland - DE

Ifremer (FR) L. Delauney Y. Faijan

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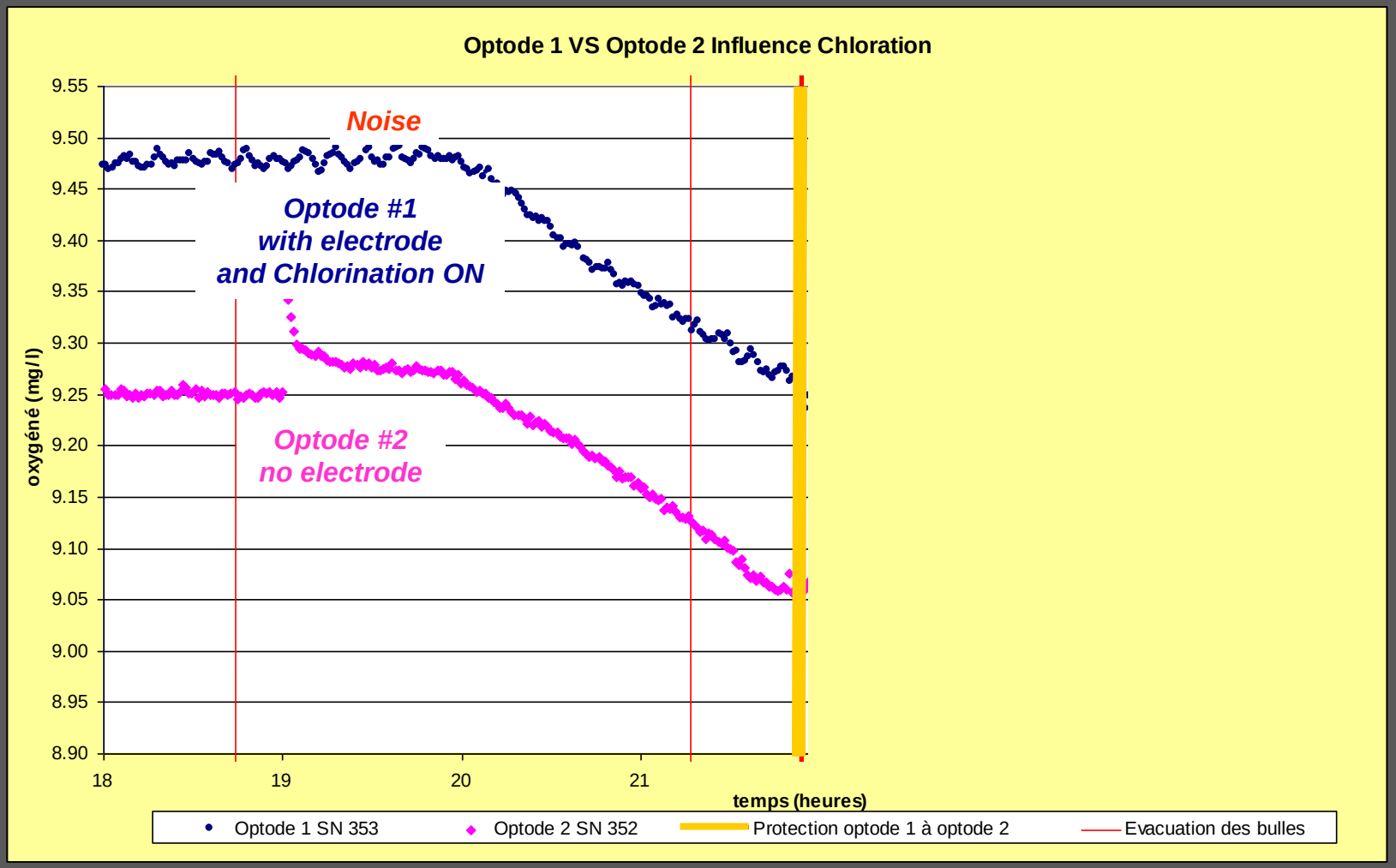
Adverse effect
on sensor measurement

One example

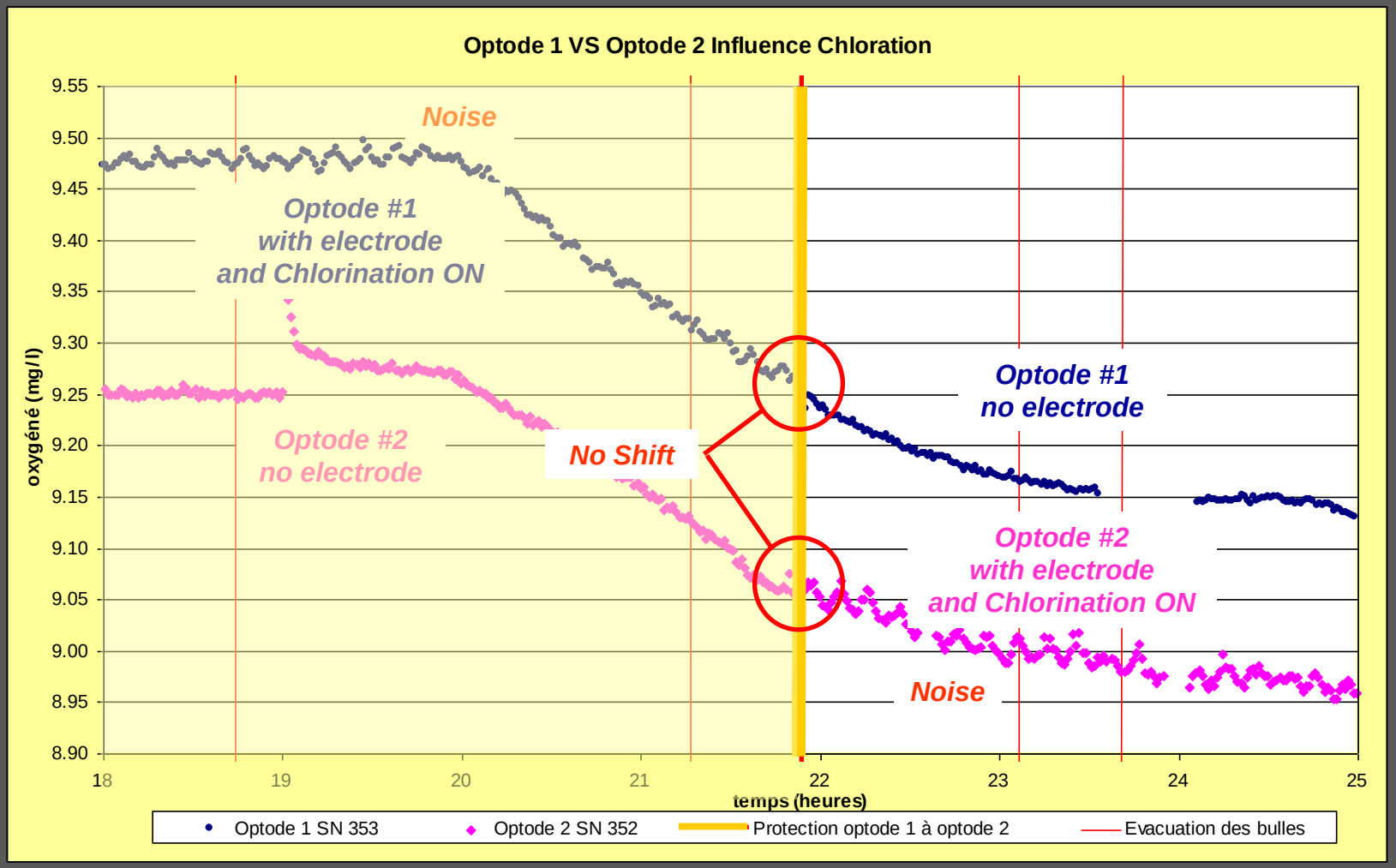
Local Chlorination
Adverse effect, laboratory check

Oxygen Measurement – Optode Aanderaa instrument



Local Chlorination
Adverse effect, laboratory check

Oxygen Measurement – Optode Aanderaa instrument



Conclusion

- Main techniques available to protect sensors:
  - Wipers
  - Copper and copper shutter
  - Bleach (biocide injection)
  - Local chlorination

- The choice can be driven by different aspects :

  Hardware matter :
  - Robustness (depth of use)
  - Mechanical complexity
  - Easiness of adaptation to the existing instrument
  - Level of integration

  Metrological aspect :
  - Adverse effect to the measured parameter.
  - Is system can be turned on and off.

  Economical aspect :
  - Availability on the market.
  - Price.

Conclusion

- Main techniques available to protect sensors:
  - Wipers 3/5 (endurance problem of the wiper material)

- The choice can be driven by different aspects :

  Hardware matter :
  - Robustness (depth of use) : 2/5
  - Mechanical complexity : 2/5
  - Easiness of adaptation to the existing instrument : 2/5
  - Level of integration : 2/5

  Metrological aspect :
  - Adverse effect to the measured parameter : 5/5
  - Is system can be turned on and off : YES

  Economical aspect :
  - Availability on the market : YES (adaptable as well)
  - Price : 3/5

- Suitable for Optical sensors.
- Pay attention on the soft material used for the wiper.

Conclusion

- Main techniques available to protect sensors:
  - Copper : 3/5

- The choice can be driven by different aspects :

  Hardware matter :
  - Robustness (depth of use) : 5/5
  - Mechanical complexity : 4/5
  - Easiness of adaptation to the existing instrument : 3/5
  - Level of integration : 5/5

  Metrological aspect :
  - Adverse effect to the measured parameter : 3/5
  - Is system can be turned on and off : NO

  Economical aspect :
  - Availability on the market : YES
  - Price : 3/5

- Suitable for Optical and conductivity sensors
- Adverse effect for oxygen sensor

Conclusion

- Main techniques available to protect sensors:
  - Copper shutter : 3/5

- The choice can be driven by different aspects :

  Hardware matter :
  - Robustness (depth of use) : 2/5
  - Mechanical complexity : 2/5
  - Easiness of adaptation to the existing instrument : 2/5
  - Level of integration : 1/5

  Metrological aspect :
  - Adverse effect to the measured parameter : 3/5
  - Is system can be turned on and off : NO

  Economical aspect :
  - Availability on the market : YES
  - Price : 2/5

- Suitable for Optical sensors
- Adverse effect for oxygen sensor

Conclusion

- Main techniques available to protect sensors:
  - Bleach (biocide injection) : 4/5

- The choice can be driven by different aspects :

  Hardware matter :
  - Robustness (depth of use) : 2/5
  - Mechanical complexity : 2/5
  - Easiness of adaptation to the existing instrument : 2/5
  - Level of integration : 1/5

  Metrological aspect :
  - Adverse effect to the measured parameter : 3/5
  - Is system can be turned on and off : YES

  Economical aspect :
  - Availability on the market : YES (but not as a kit)
  - Price : 2/5

- Suitable for every sensors
- Adverse effect for sensor if badly flushed

Conclusion

- Main techniques available to protect sensors:
  - Local chlorination : 4/5

- The choice can be driven by different aspects :

  Hardware matter :
  - Robustness (depth of use) : 5/5
  - Mechanical complexity : 3/5
  - Easiness of adaptation to the existing instrument : 4/5
  - Level of integration : 3/5

  Metrological aspect :
  - Adverse effect to the measured parameter : 4/5
  - Is system can be turned on and off : YES

  Economical aspect :
  - Availability on the market : YES
  - Price : 3/5

- Suitable for every sensors
- Adverse effect on oxygen, can be turned OFF.

Conclusion

- Main techniques available to protect sensors:
  - Local chlorination on coated windows : 4/5

- The choice can be driven by different aspects :

  Hardware matter :
  - Robustness (depth of use) : 5/5
  - Mechanical complexity : 4/5
  - Easiness of adaptation to the existing instrument : 2/5
  - Level of integration : 5/5

  Metrological aspect :
  - Adverse effect to the measured parameter : 3/5
  - Is system can be turned on and off : YES

  Economical aspect :
  - Availability on the market : NO (still in developpement)
  - Price : -

- Suitable for optical sensors
- No Adverse effect, can be turned OFF.

Thank you for your attention.