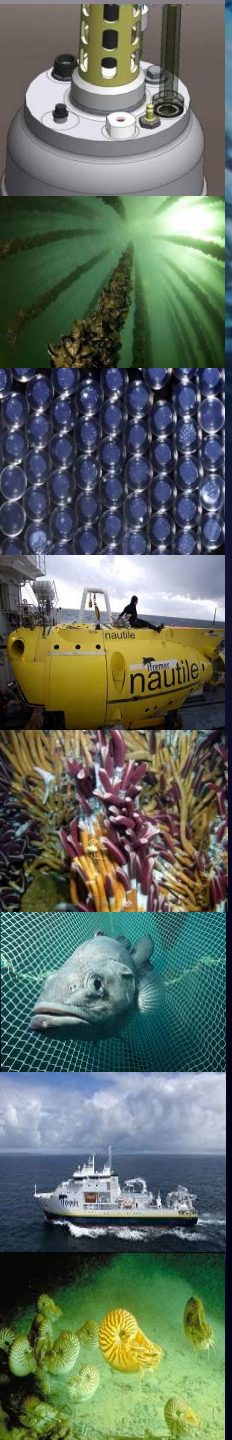


Integration of an *in situ* biogeochemical sensor for nitrate determination on an ARGO profiling float (Provor) and the Sterne glider

D. Malardé, A. Laës-Huon, V. Dutreuil, S. Le Reste, D. Le Roux, B. Lossouarn (Ifremer)
I. Probst (ENSTA-Bretagne)
F. D'Ortenzio (the LOV)

EGO 2011 - 17 March 2011

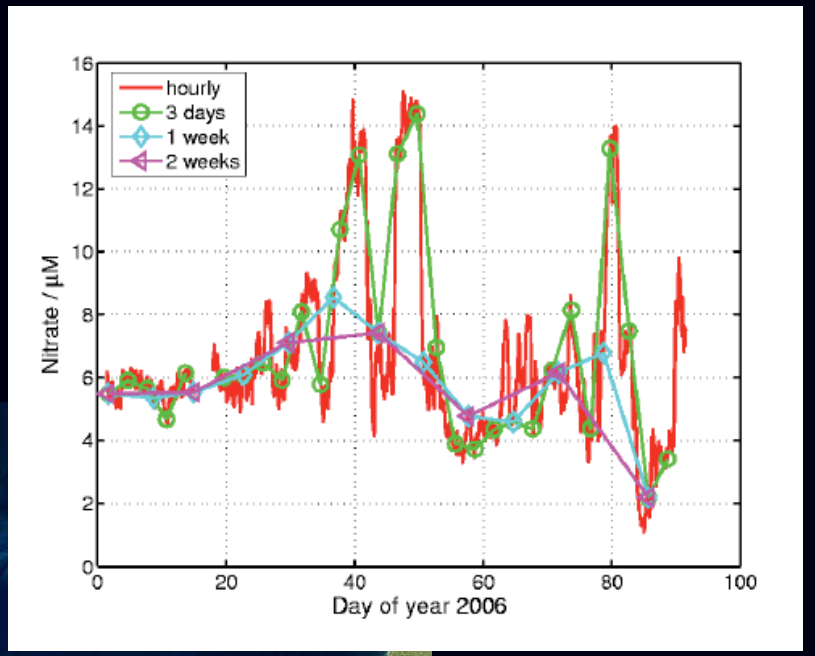
Introduction

Improvement of temporal distributions of chemical species

Undersampling ecosystem

⬇

High-frequency temporal series



Johnson and Coletti (2002)

Importance of brief and episodical phenomena

Mesoscale Eddies McGillicuddy et al. (2008)

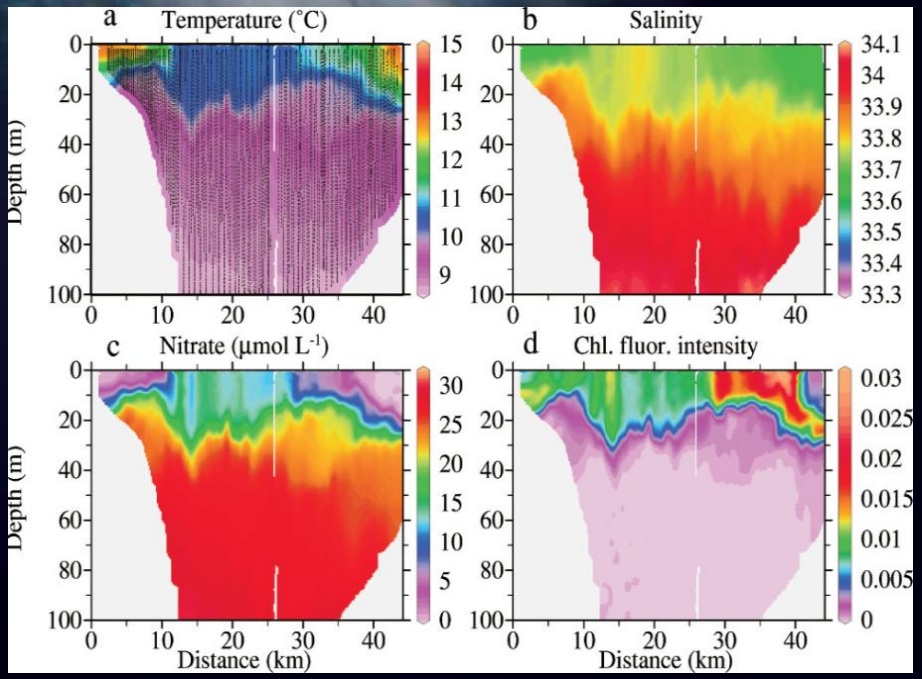
Aperiodic weather events Chapin et al. (2004)

Variations related to the tidal cycles Chapin et al. (2004)

Algal bloom (phytoplankton) Prien et al. (2007)

Introduction

Improvement of spatial distributions of chemical species



Johnson and Needoba (2008); Johnson and Coletti, (2002)

High spatial and temporal resolution measurements of nitrate concentration

Improvement and validation
of the coupled Hydrodynamic/biogeochemical models

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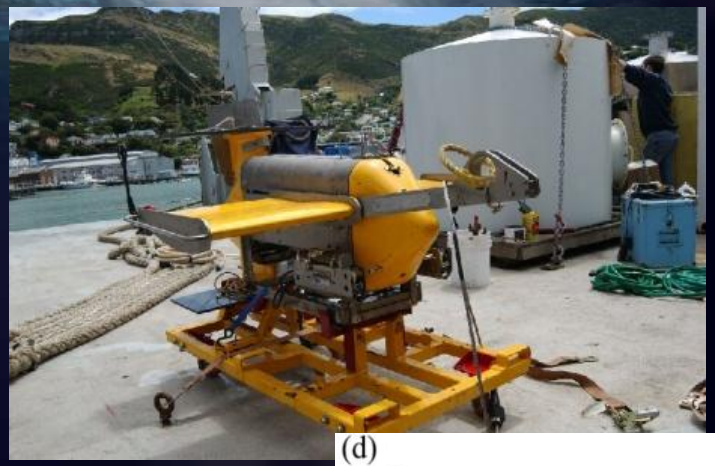
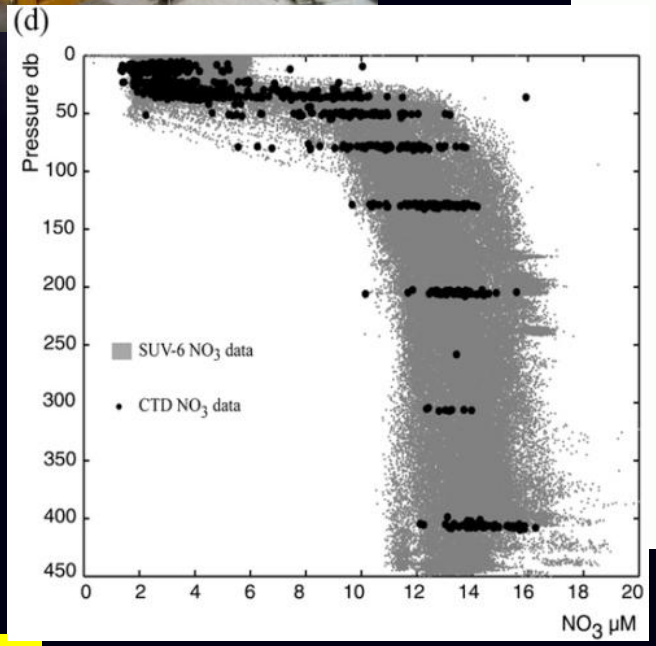
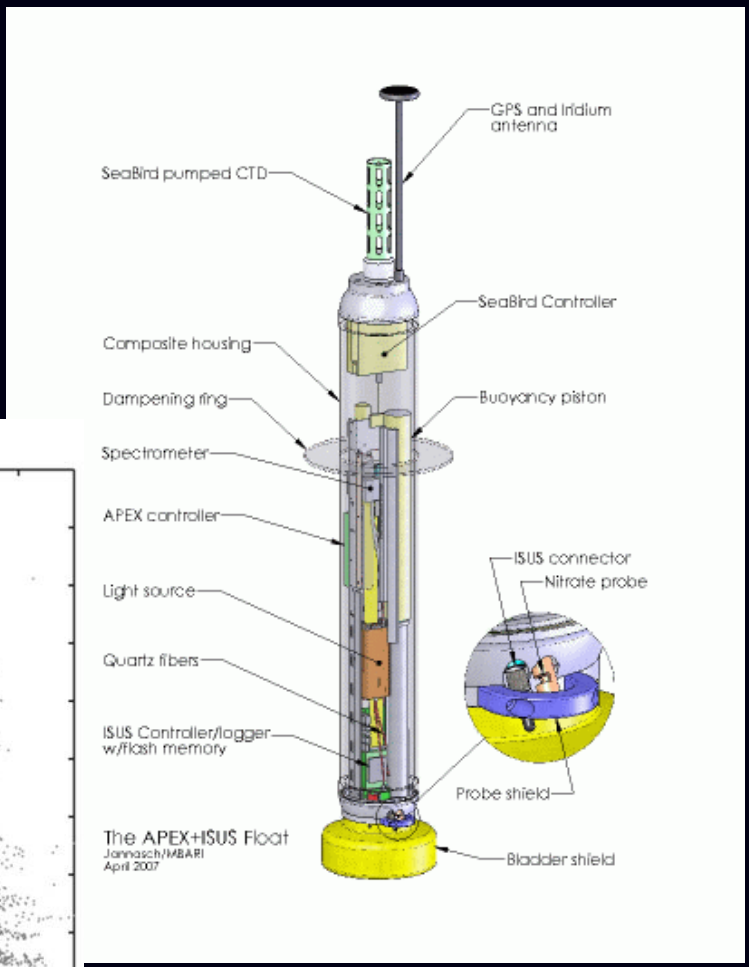
Introduction

Include optical nutrients sensors on several vehicles





Pidcock et al. (2010)



Riser et al. 2009

Introduction

Accessible Vehicles

Sterne glider

Provor CTS3 float







Summary

- Introduction
- Electronical integration
- Metrological tests
  - Temperature
  - Salinity
  - Turbidity
- Mechanical integration
  - ISUS/Provor CTS3 float architecture
  - Tributyltin effects (Biofouling)
  - Modelisation of Sterne glider
  - ISUS/Sterne glider architecture
- Conclusion
- Perspectives

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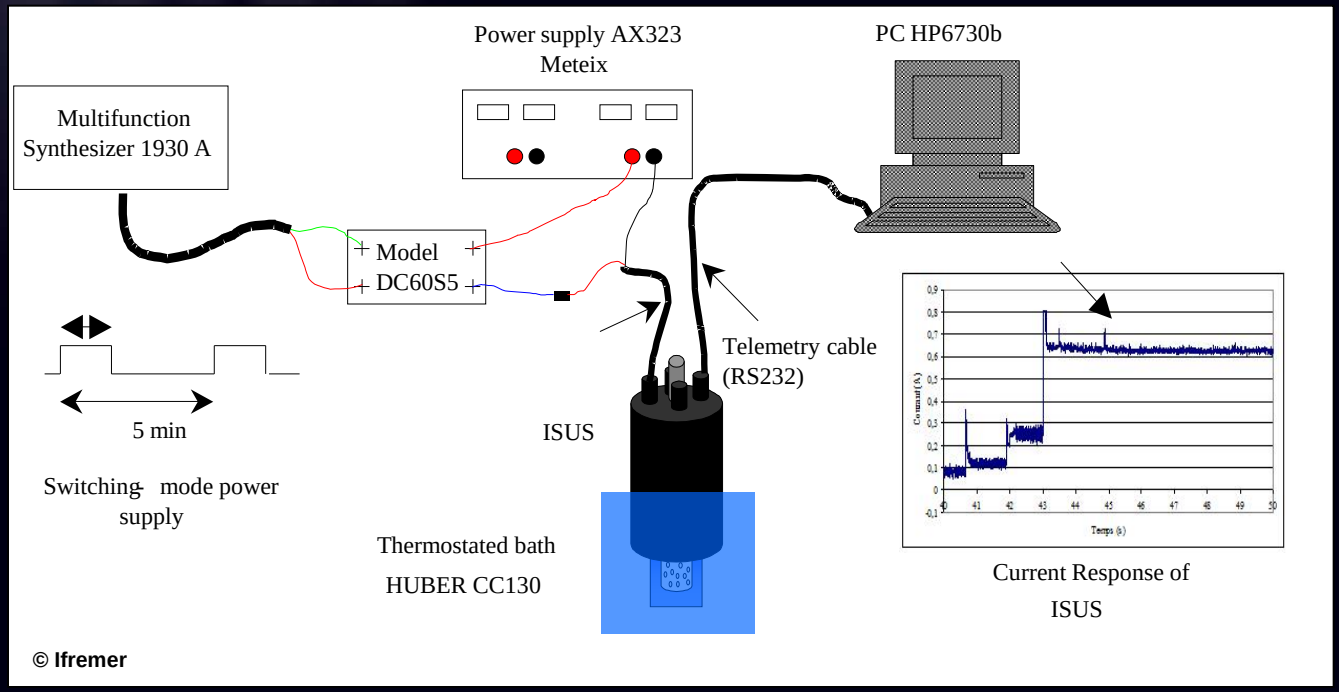
Electronical integration

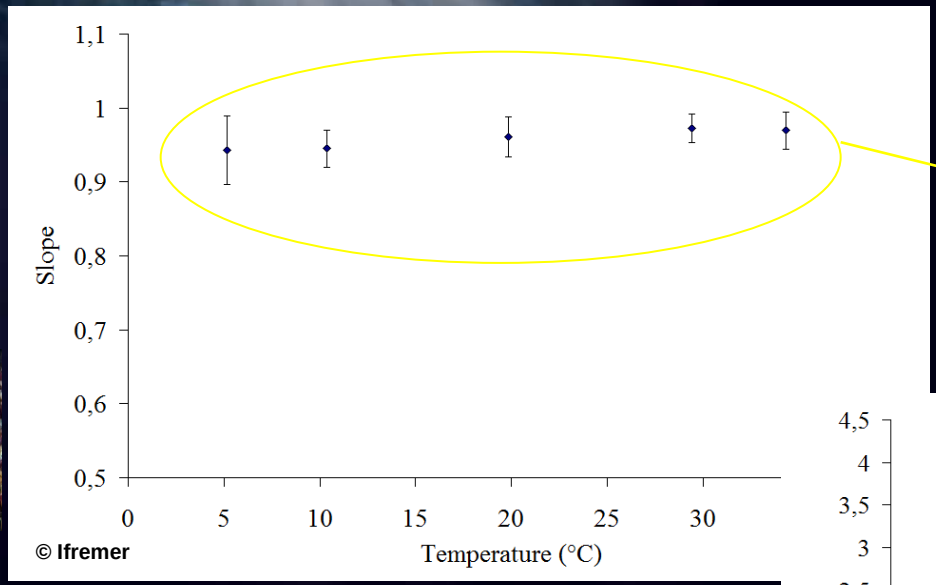
- **Operating process of the ISUS sensor:**
  - **Define the electronical interfacing**
  - **Adapt the software**

- **Energy management:**
  - **Optimize the switching-mode power supply**
  - **Determine the response time**



Metrological tests

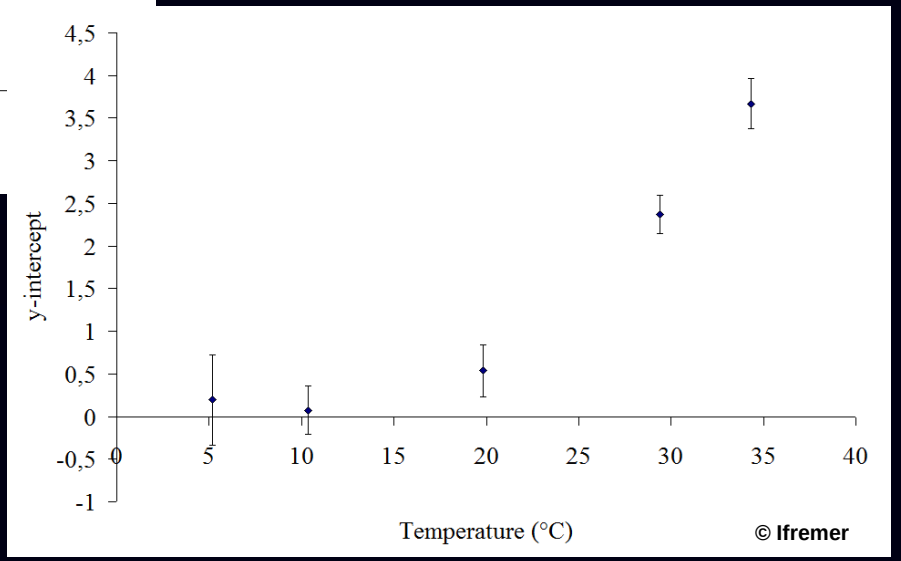
Sensitivity of nitrate concentration measurement to temperature



Sensitivity of ISUS not affected by temperature variation in the oceanic range 5-35°C

Variation of the y-intercept

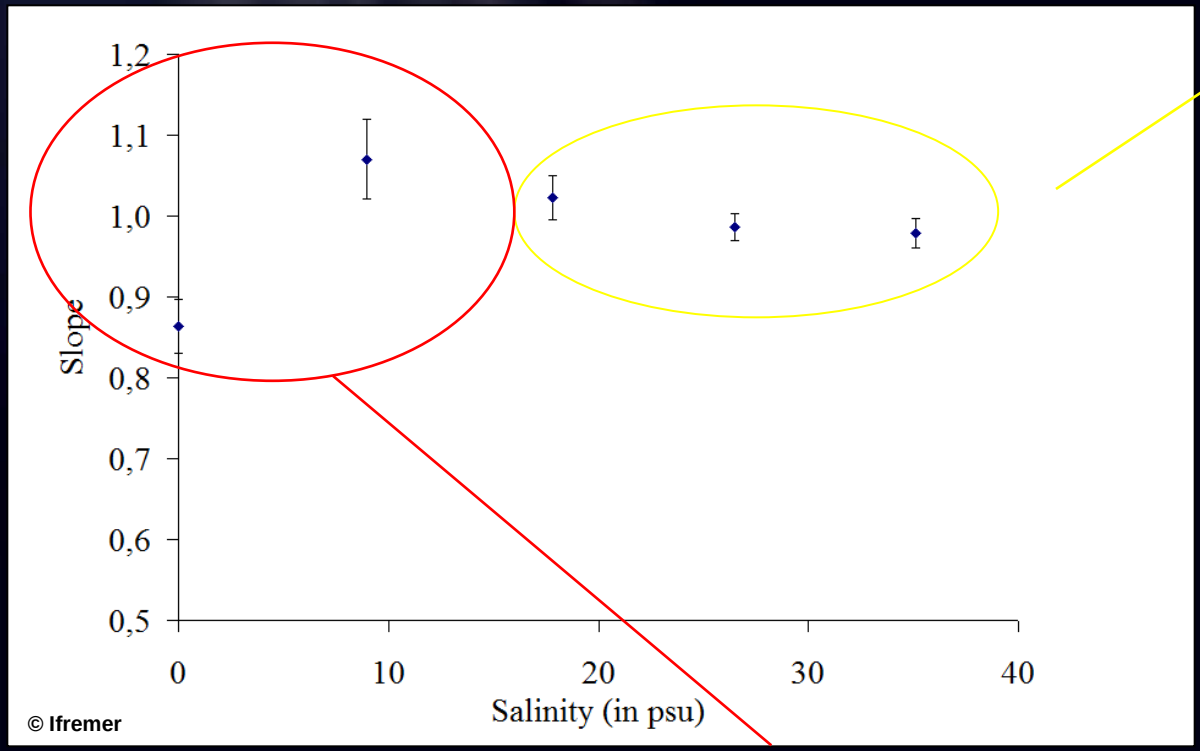
Limit the accuracy of nitrate



Metrological tests

Sensitivity of NO_3^- concentration measurement to salinity

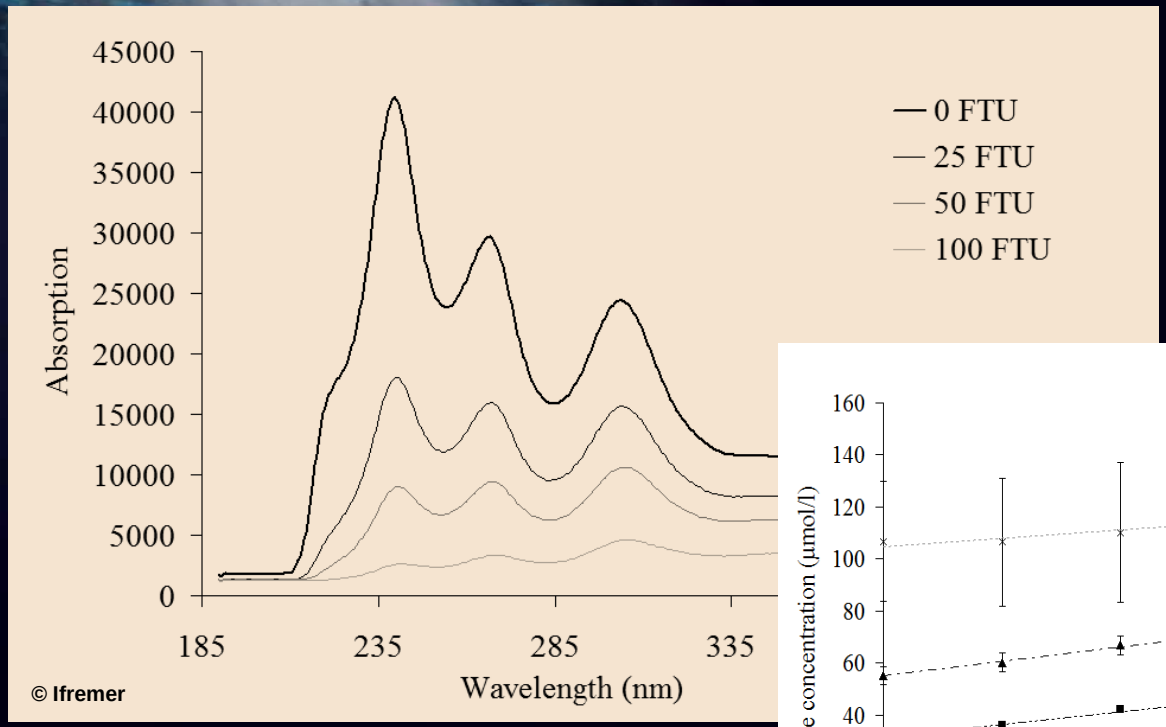
ISUS response not sensitive to salinity variation in the oceanic range 20-35 PSU

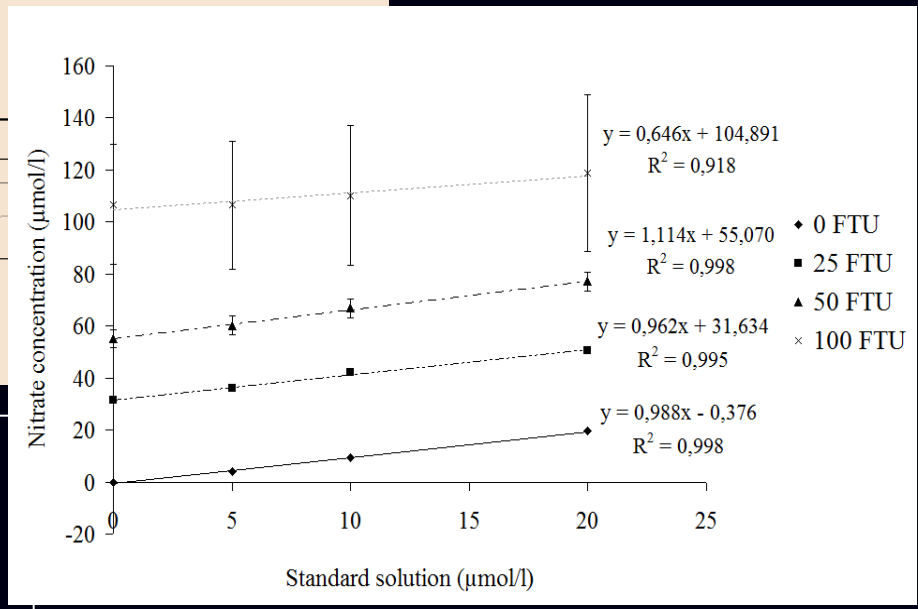


Sensitivity of ISUS affected for lower salinity(0-20 PSU)

Metrological tests

Sensitivity of NO_3^- concentration measurement to turbidity





Poor Detection beyond 100 FTU

+

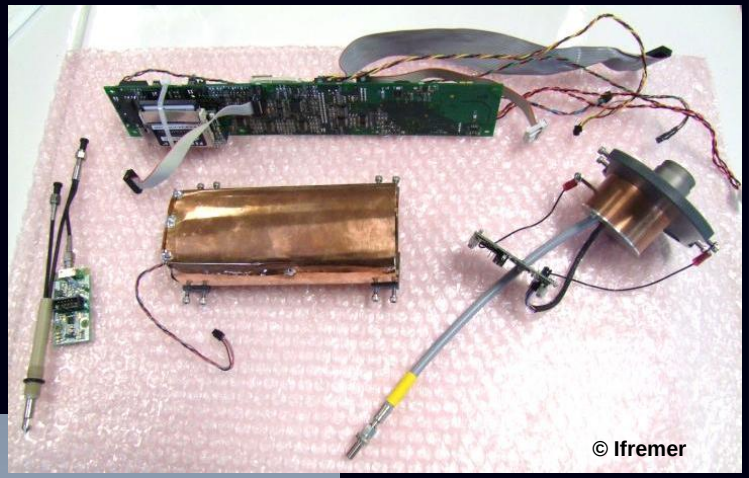
Noise/signal ratio increases

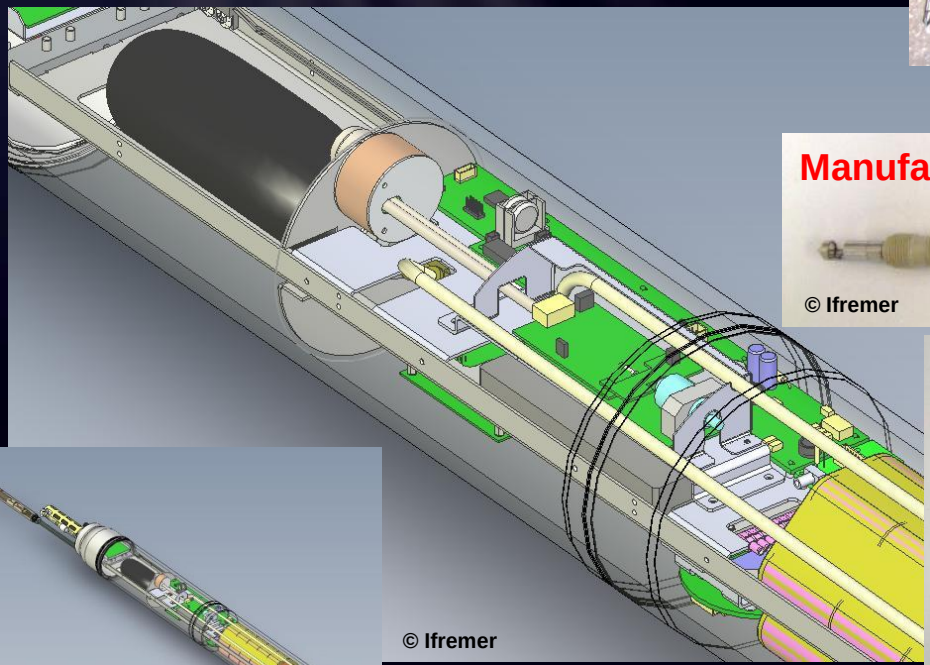
➢ **Limit coastal application**

Mechanical integration
(PROVOR CTS3)

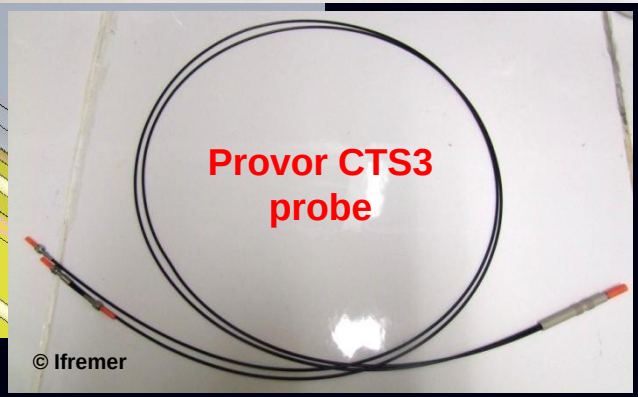
- Identifying the optical constraints
- Dimensioning the various electronic and optical elements

- Results: Modification of the optical probe





Manufactured probe



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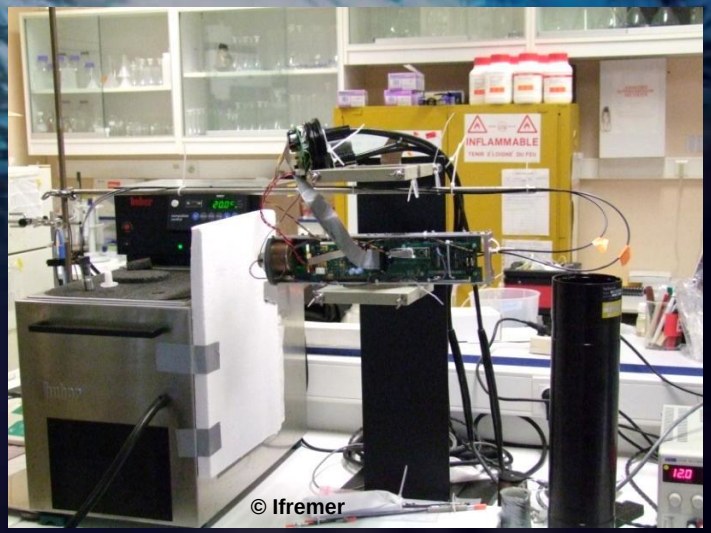
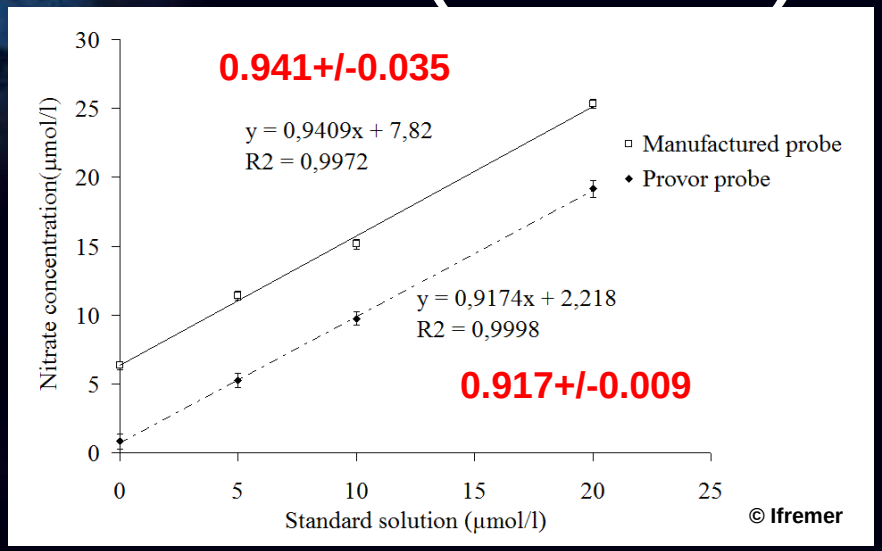
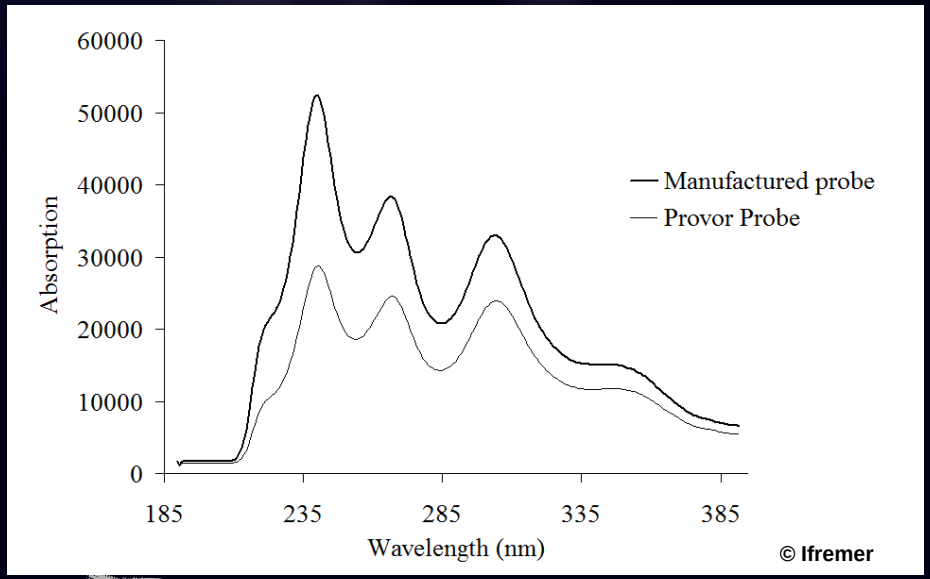
Mechanical integration
(PROVOR CTS3)

New ISUS architecture (Provor)





Calibration performed using Aquil* and « Provor » ISUS

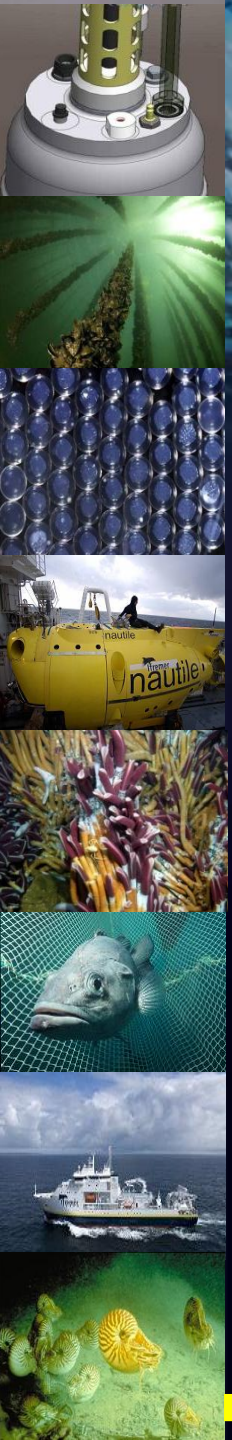


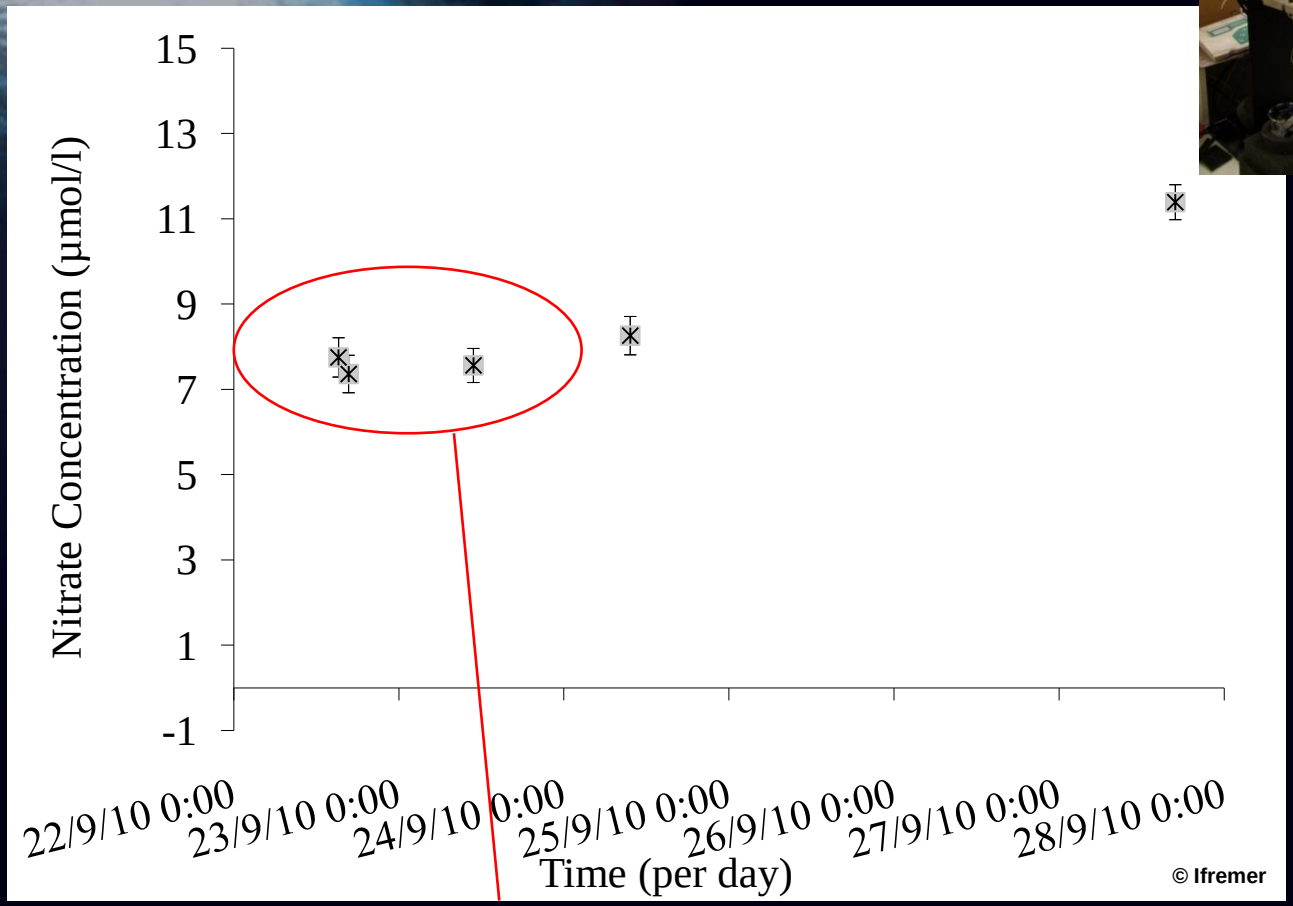
Standard solution	C_{N03-} (µmol/l) [1]	S. D*
0 µmol/l	6.33	**0.28**
5 µmol/l	11.41	**0.30**
10 µmol/l	15.13	**0.35**
20 µmol/l	25.34	**0.33**
Standard solution	C_{N03-} (µmol/l) [2]	S. D*
0 µmol/l	0.83	**0.54**
5 µmol/l	5.25	**0.49**
10 µmol/l	9.75	**0.49**
20 µmol/l	19.15	**0.61**

[1] Manufactured ISUS

[2] Provor ISUS

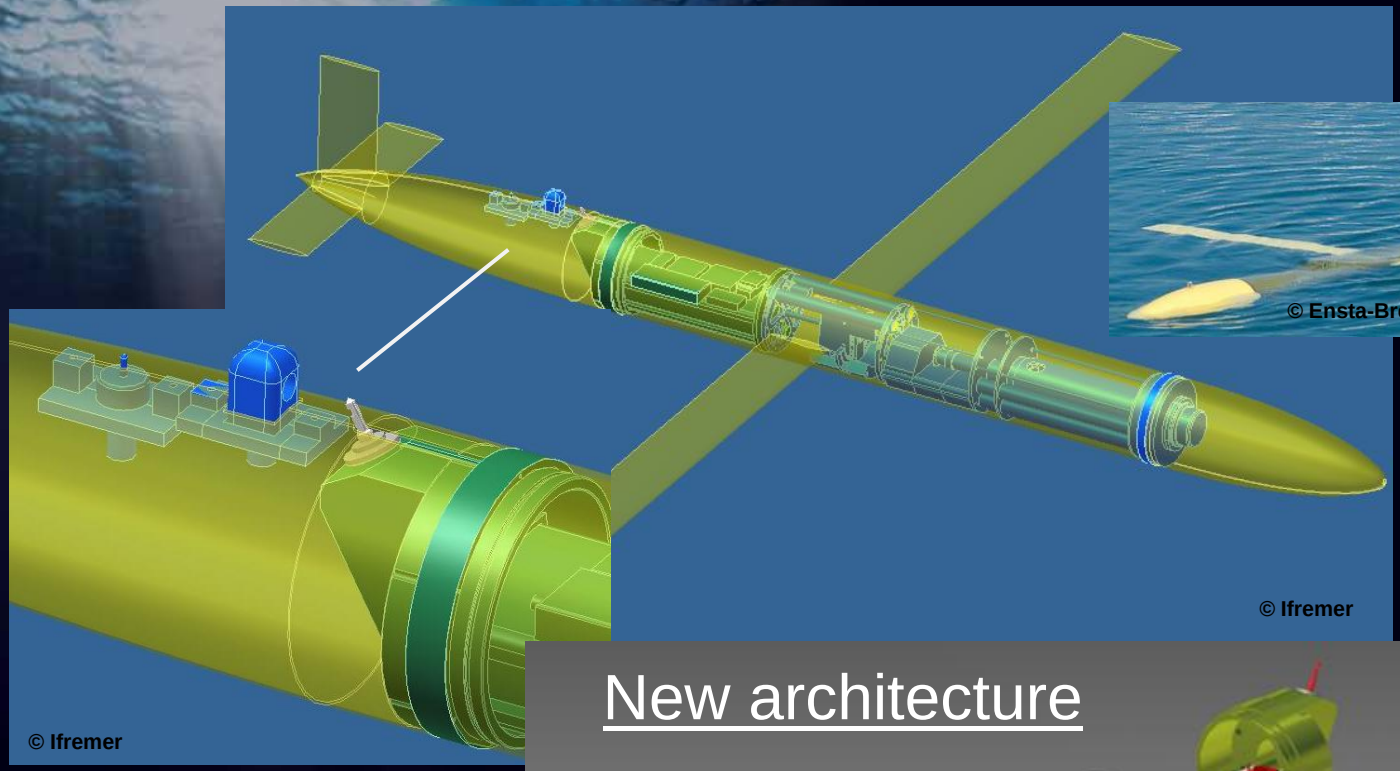
Tributyltin effects



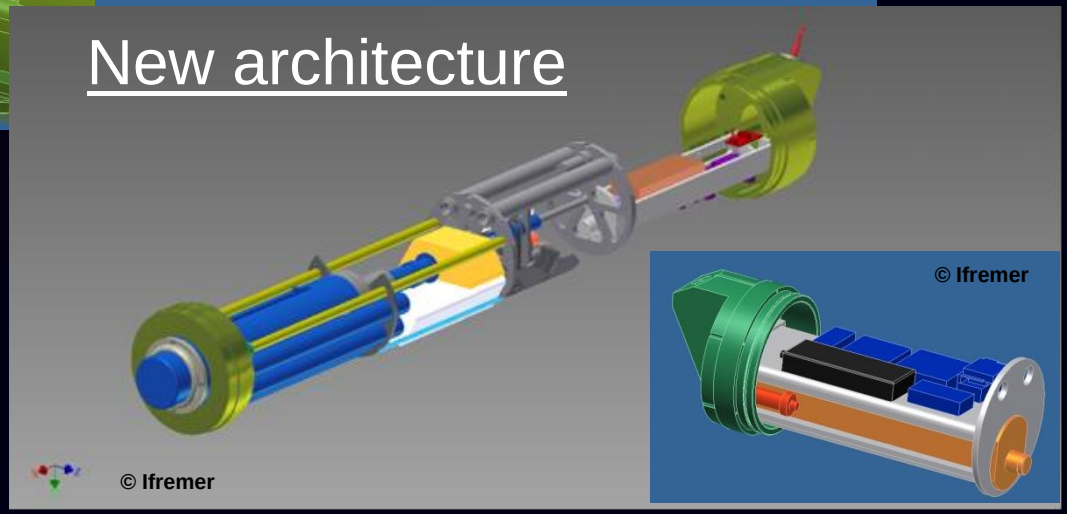


Nitrate measurement not affected during the experiment time (under 24 hours)

Modelisation of STERNE glider



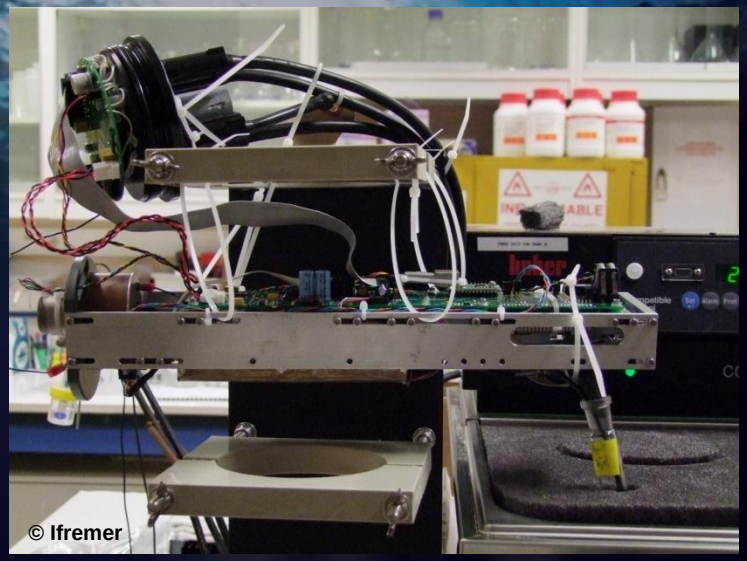
New architecture

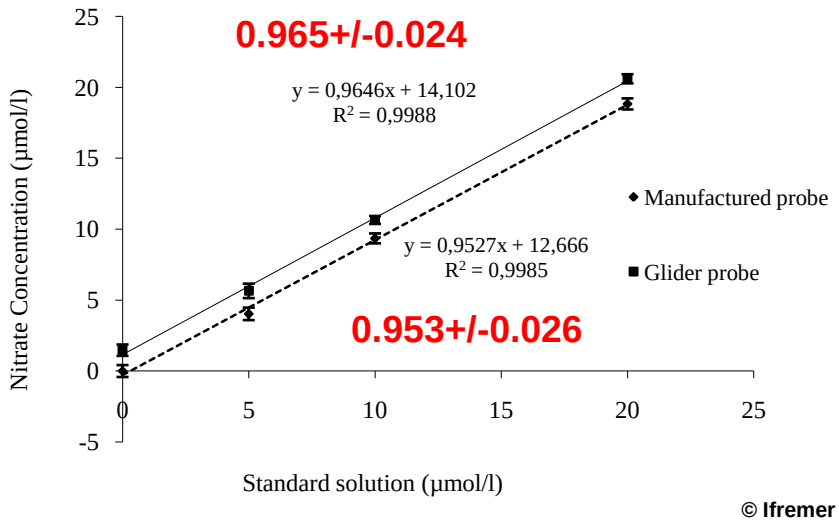


Designed by
ENSTA-Bretagne

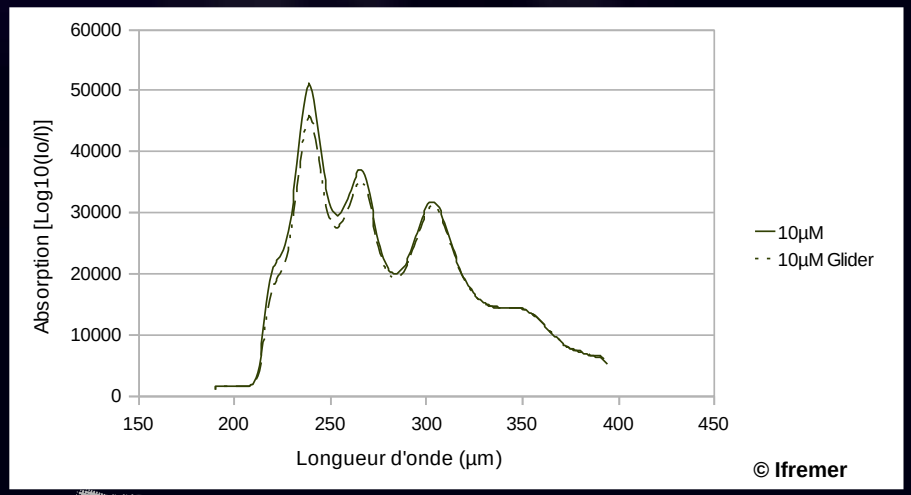
Ifremer

New ISUS architecture (Sterne)





Calibration realized with Aquil* and « manufactured » ISUS



Standard solution	C_{N03-} (µmol/l) [1]	S. D*
0 µmol/l	0	**0.42**
5µmol/l	4.03	**0.44**
10 µmol/l	9.35	**0.35**
20 µmol/l	18.83	**0.39**
Standard solution	C_{N03-} (µmol/l) [2]	S. D*
0 µmol/l	1.47	**0.4**
5 µmol/l	5.65	**0.51**
10 µmol/l	10.65	**0.28**
20 µmol/l	20.6	**0.32**

[1] Manufactured ISUS

[2] Glider ISUS

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Conclusion

- **Validation of Metrological tests (T°C, Salinity)**
- **Turbidity:**
  Poor detection of nitrate beyond 100 FTU
- **Protection against biofouling**
- **PROVOR: Successfull integration (mechanical and metrological)**
- **Glider: Promising results (mechanical to be tested)**
- **Collaboration in VASQUE Framework (LOV, Ifremer, ACSA, COM)**
  « Integration of biochemical sensor on Hybrid vehicle Seaexplorer »

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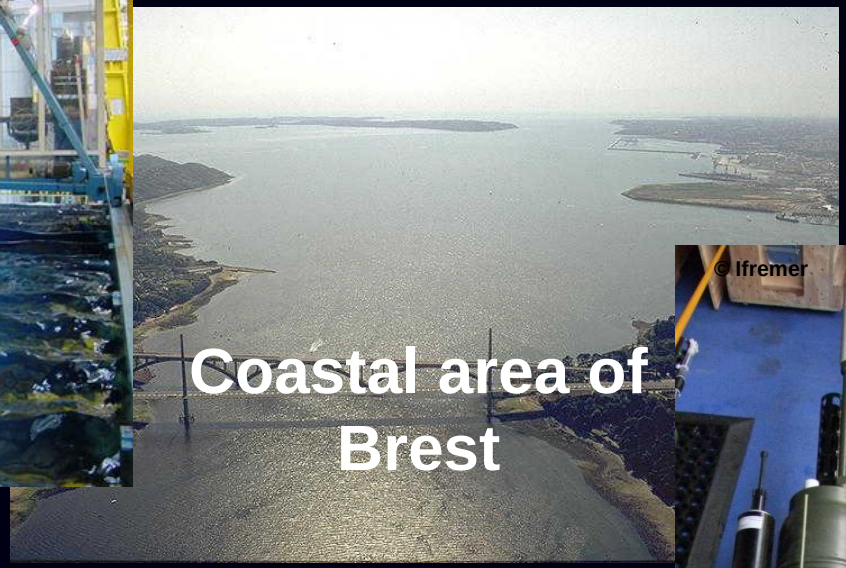
Perspectives PROVOR

Deployment scheduled

March-April 2011



- **Comparison with another PROVOR profiling float equipped with a SUNA sensor**

Moose framework (L. Coppola)

Perspectives Glider

- **Manufacture the new architecture of Sterne Glider**
- **Tests scheduled in a seawater pool (Ifremer)**