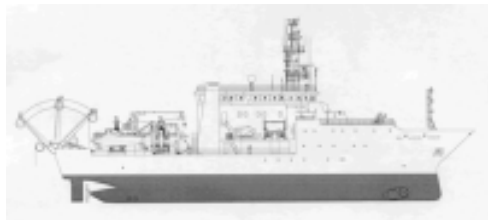




# Welcome On Board



<http://www.ifremer.fr/flotte/index.html>



**Ifremer**



# **Operational Feedback of the ASTER<sup>X</sup> AUV and interoperability of sub systems with Victor6000**

**Dr Vincent Rigaud**

**Director of the underwater system Dept.  
vincent.rigaud@ifremer.fr**



# Ifremer Operational Underwater System

From survey

to

Intervention

Autonomous



*ASTERX 3000m  
, 100km, 24h*

Cabled systems



*>100km  
Sev Days*



*local, sev h*



*sev km, 72h*

HOV



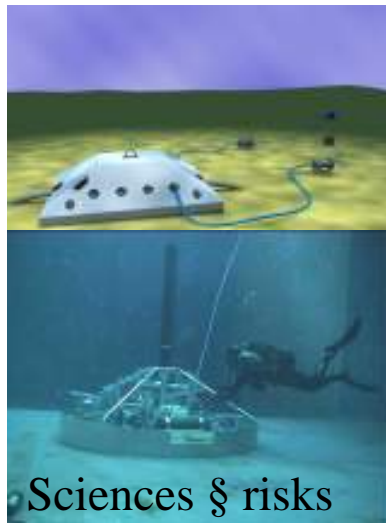
*sev km, sev h*

Spatial  
(mobile)

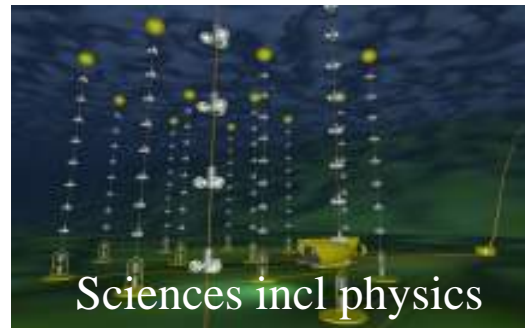
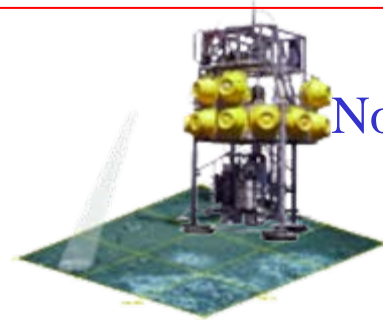
Ifremer

Non cabled observatories

No real Time,  
*local several months*



Sciences § risks



Sciences incl physics



Offshore Technological heritage

Temporal  
(fixed)

RT Observatories- Real time

*Permanent, local, networked*



Operational AUVs, Old stories

EPAULARD

**Present Objectives in some words:**

**From “pioneer” Sciences, discoveries and knowledges in oceanography to operational surveillance of phenomena and interventions to act for a durable exploitation and understanding of the sea**

**Data collection cost optimisation**

**A place for AUVs in the operational fleet...  
Amongst others...**

# Coastal survey AUV program Genesis



Ifremer

- 80-95 After Epaulard, developed for polymetallic nodules survey program, Ifremer has frozen AUV Development and has focused on Deep Sea ROV and Manned Sub Nautilie mainly for **deep sea research observation and intervention.**
- 95-2002 Contributive R and D mainly active in collaboration in the offshore domain since 1993 with numerous world first in intervention and inspection AUV (SIRENE,ALIVE,WIMMER): **Technological and economical push**
- 2002-...Evolution of programs from « observation » to « survey » of the environment : new tools are needed to optimized data collection and interpretation  
**Scientific and operational programs pull**





# intervention AUV

Valorisation phase 2

(ALIVE – Cybernetix-Ifremer-HWU-Hitec)

- In
- H

↓127 P078 C282 A....



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# Ifremer Coastal AUV program: Needs by domains

➤ **Access to high frequency, blind areas, and optimisation of spatial-data collection cost**

➤ physics/chemical survey:

- **Access to high frequency.**
- **Access to interfaces**

● Halieutic survey:

- **blind areas**
- **Coupling with physics**

● Mapping/Geosciences :

- **High resolution, risk assesment , slope stability gaz hydrates, Canyons ...**

# Dogmas and methods for an operational system



**Security of navigation ; surfacing only if acoustic com is possible, I.e. a ship can guarantee the water plan policy**

- **operations from opportunity ship, I.e small LARS and flexible methods, with obviously no divers and up to Sea state 5**
- **Technology of subsystems is now mature, but safe exploitation and cost of possession optimisation is an issue- 2- 3 Crews, Commercial cost around 5000€/day**
- **External Tender for a basic (but nice) “open” and evolutive vehicle and Ifremer internal devt for :**
  - the Exploitation tools design (soft and hardware) (Mimosa® and CARAIBES®)
  - The high level control (PSE®)
  - The payloads developments
  - The LARS design (Calyste®)
  - The Navigation and positioning systems (Triades®, Moana®)
  - The acoustic synchronisation system (OSEA®)
  - The at sea qualifications

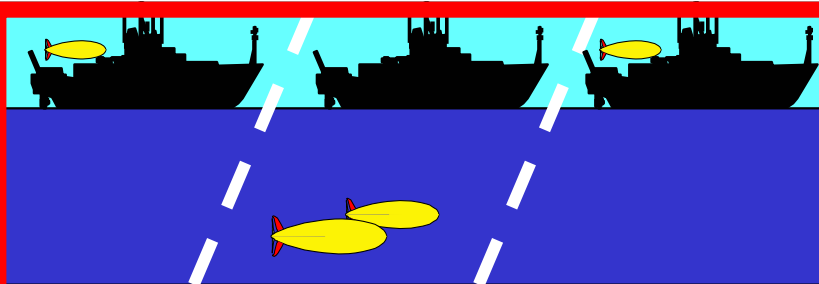
# Usage modes analysis



Ifremer

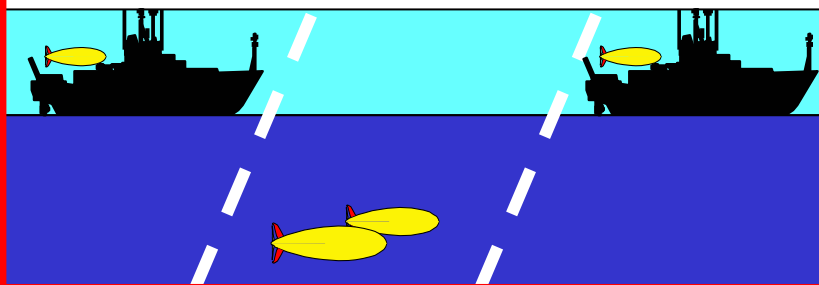
Pro

Con



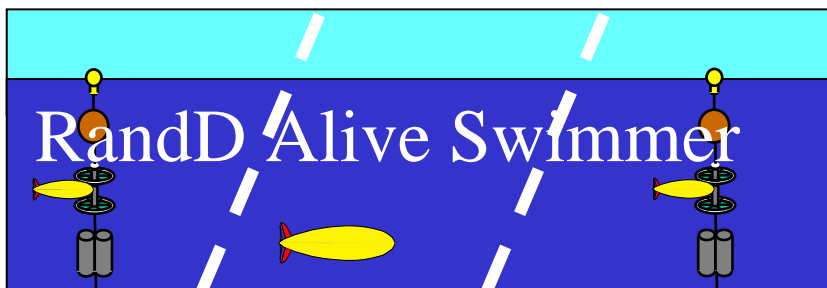
- \* Navigation by tracking
- \* Faster deep survey
- \* Multiple platforms

- \* Ship costs dominate



- \* Ship free for additional activity

- \* Navigation an issue



- \* Episodic response
- \* Rough weather ops
- \* Multiple platforms
- Space-time cov
- No ship

- \* Complex
- \* Dock expensive
- \* Deployment and recovery



- \* Energy required for transit
- \* Navigation



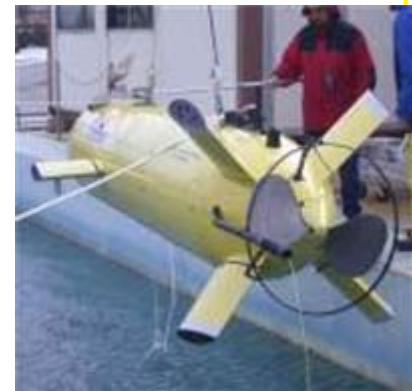
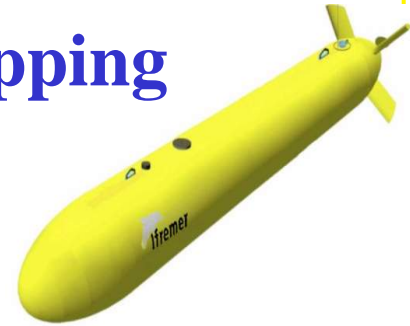
## AUV for regional and local survey :

'high resolution(HR) at high speed mapping

*Medium class survey AUV ASTER<sup>x</sup>*

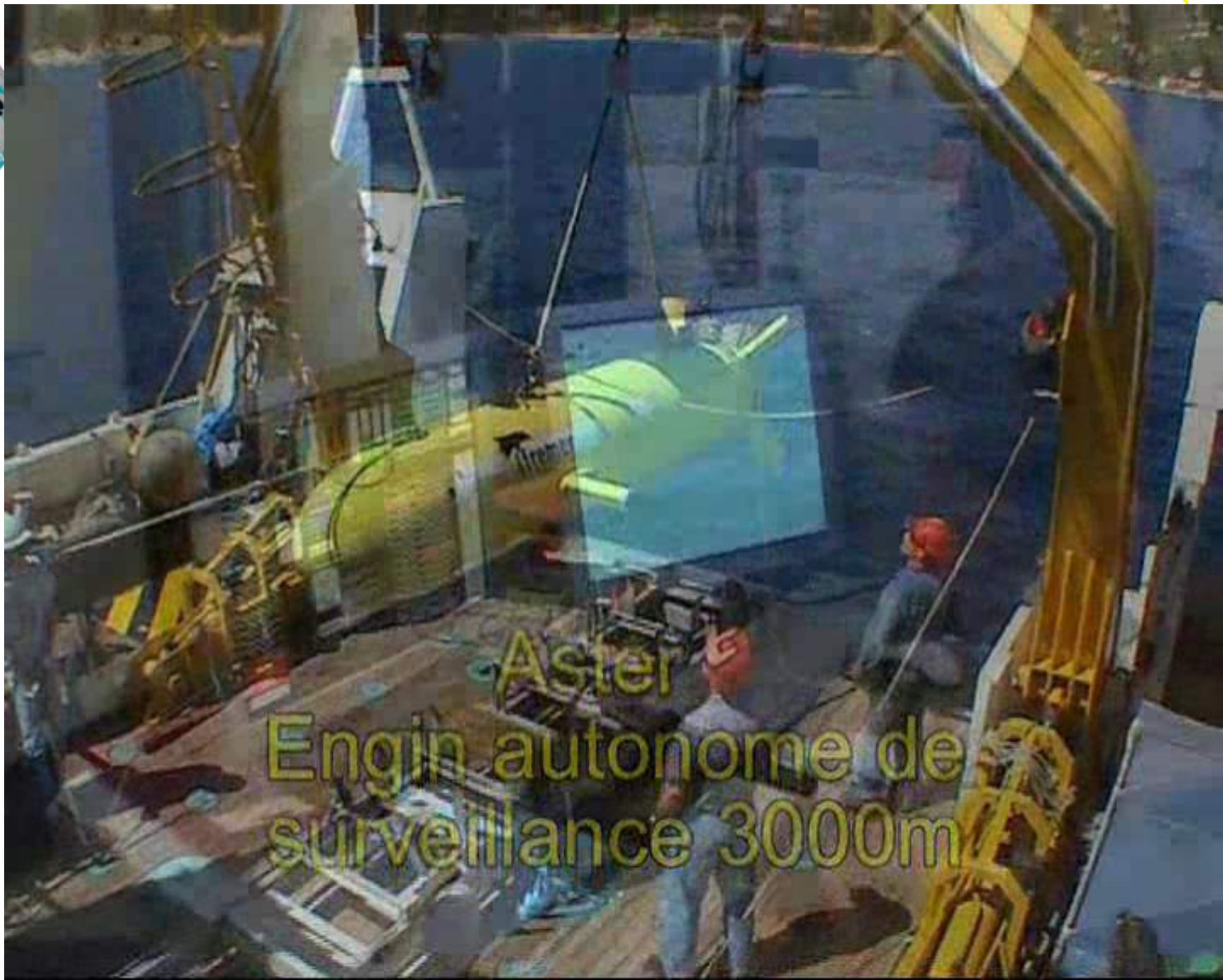
### *Expkorer Type ISE*

- Length 4.5m, total weight in air 793kg with 200kg/0,5m<sup>3</sup> « monobloc » for payload, Easy payload adaptation
- 3000m depth, Up to 100km range
- *Inertial Doppler and inverse USBL navigation*
- *Long range acoustic telemetry*
- *High flexibility for payload (Ifremer, Side scan, multibeam echo sounder, monobeam sounder, subottom profiler,CTD,ADCP, water sampling...)*





Ifremer



Aster  
Engin autonome de  
surveillance 3000m

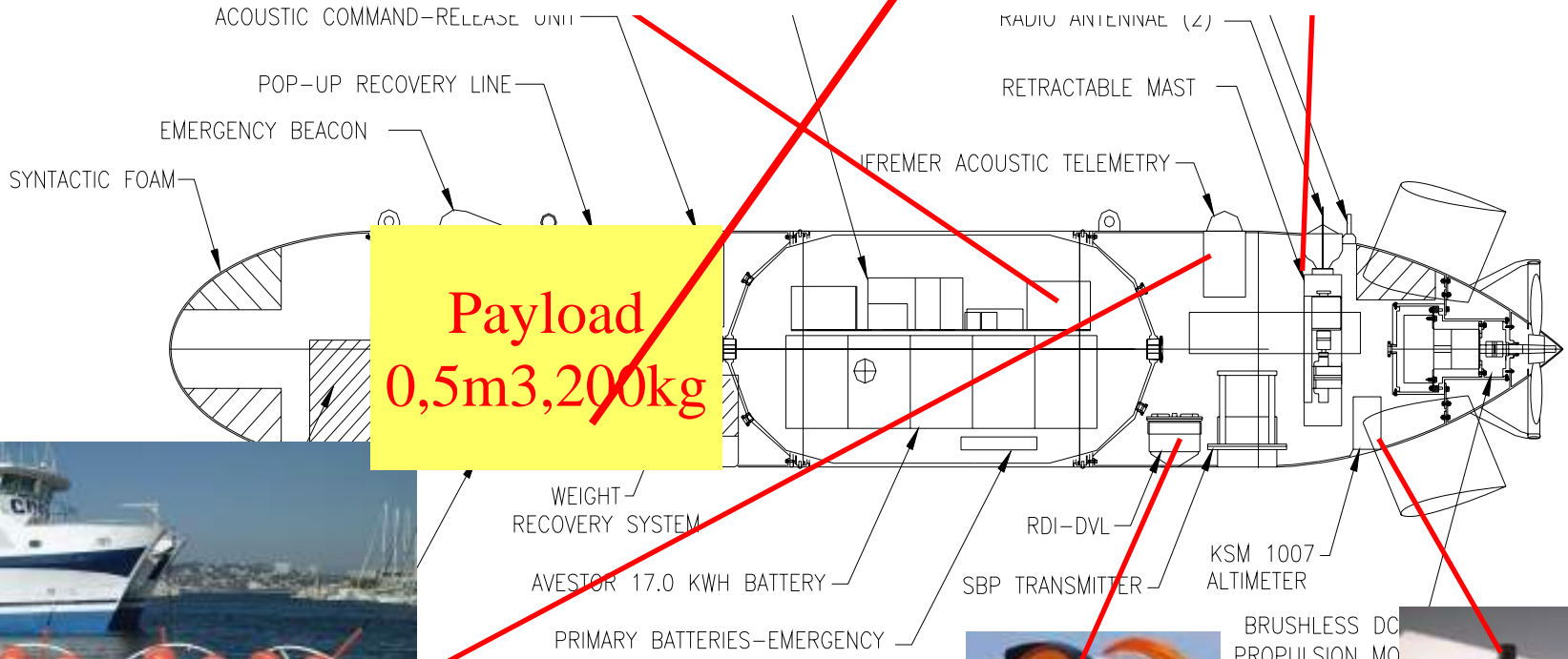
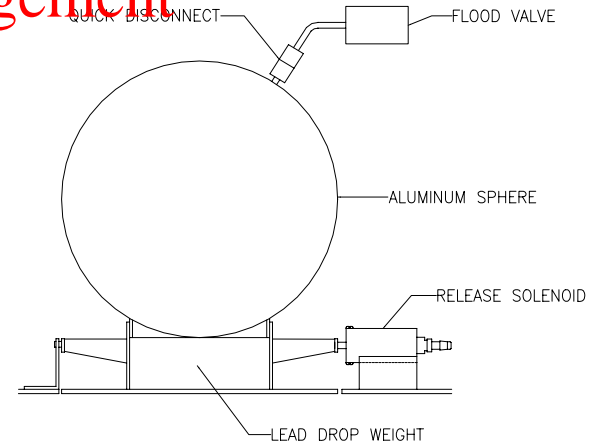
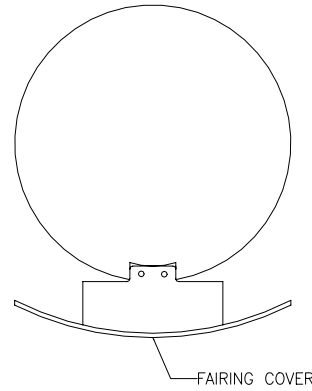
# Weight management

Inc

Ifremer



VEHICLE A



BRUSHLESS DC PROPULSION MO





# payloads

| Instrument / CU        | CTD SBE 49 | EK60 200 | EK60 75 | ADCP Wh300 | ADCP / DVL Wh300 | MB EM2000 | SBP | Mass spectrometer | Mini Wqater sampler | Turbulence probe | remarks              |
|------------------------|------------|----------|---------|------------|------------------|-----------|-----|-------------------|---------------------|------------------|----------------------|
| halieutic              |            |          |         |            |                  |           |     |                   |                     |                  | CENDRARS & Ifremer   |
| physics (testée)       |            |          |         |            |                  |           |     |                   |                     |                  | CENDRARS & COM-CNRS  |
| Geo-physic (dév. 2005) |            |          |         |            |                  |           |     |                   |                     |                  | CENDRARS & INSU      |
| geophysic2 (dév. 2006) |            | 1 de     | 2       |            |                  |           |     |                   |                     |                  | CENDRARS & INSU      |
| spectro (dév. 2007)    |            |          |         |            |                  |           |     |                   |                     |                  | Coop. AWI            |
| Turbulence (dév. 2006) |            |          |         |            |                  |           |     |                   |                     |                  | Externe projet HABIT |

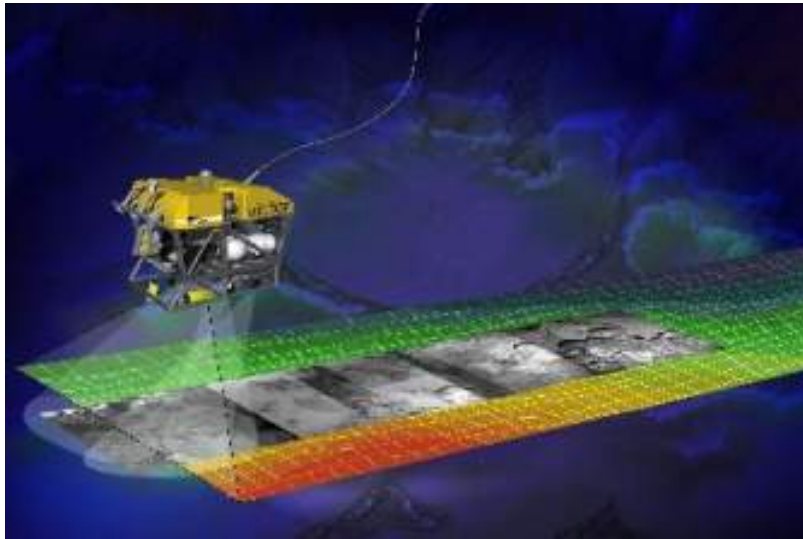


# Instrumentation and payload inter-operability between Underwater systems

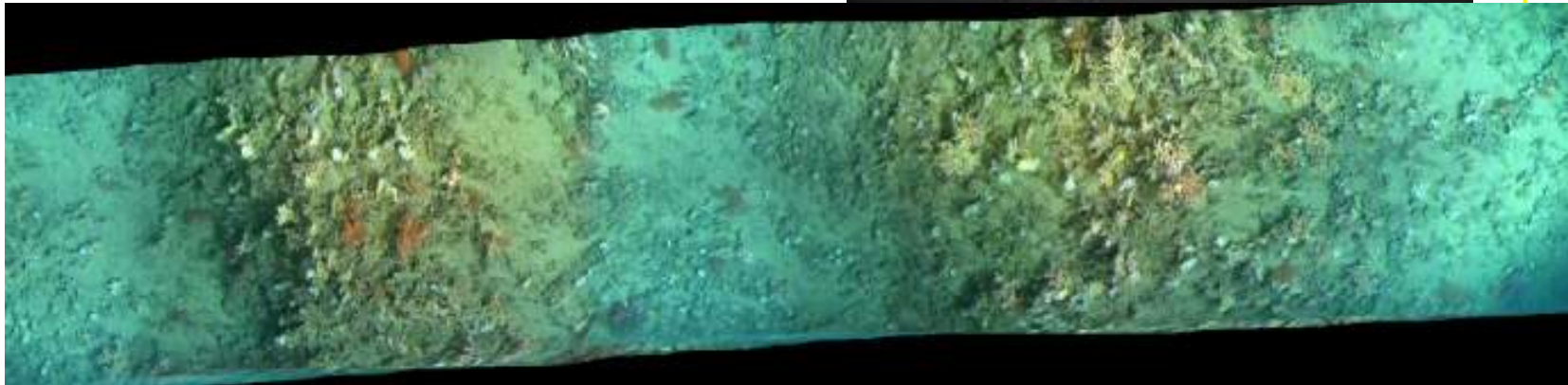
- **New ROV « module sub-systems » or « softwares » are compatible between ROVs , AUVs and deep tow**
  - EK60
  - MBS(s)- EM2000, Reson 7125
  - SBP(s)- Under devt.
  - CTD(s)- Any kind of seabird
  - ADCP(s)- any kind of RDI (300,600,1200kHz)
  - All navigation and positioning devices
  
- **General design of « standard » interfaces**
  
- **At sea inter-changeability**



# New “en route” Module: HR multimodal mapping with Multibeam and optic In cooperation with AWI



+ ground truth  
of surface surveys,  
With instrumentations  
and  
teleoperation



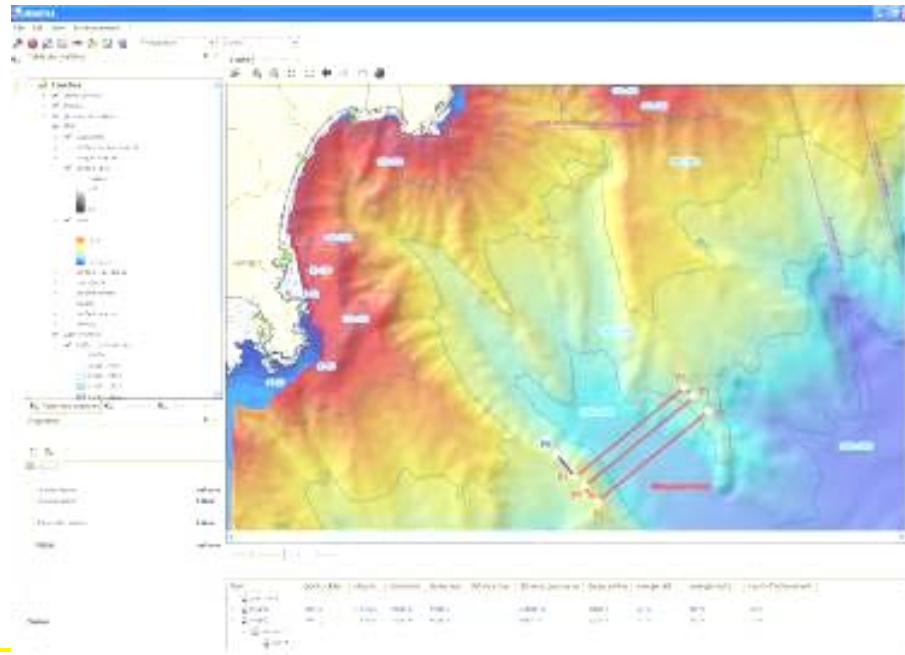
real time video mosaic, site Rockall

Ifremer



## Mimosa® for mission building and PSE© for high level reactive programming and control

- *A GIS based system for WPM, but also:*
  - Auto-check list,
  - Bathy+underwater current atlas,
  - Behaviour simulation
  - Security function,
  - Ergonomic mission building tools...
- *PSE\_ hybrid fault tolerance approach*





# Feedback *ASTER<sup>X</sup>* On a learning curve

February 2004 – February 2006:

|                               |       |
|-------------------------------|-------|
| Technical dives/Days at sea : | 65/49 |
| 5 Technological cruises :     | 70/31 |
| 5 Scientific cruises :        | 58/40 |

ETAUVHAL sur R/V Thalia , Atlantic 23-28/06/04

ALLEGRO sur R/V Heincke , North Sea 28/02-14/03/05

AUVPHY sur R/VL'Europe , Méditerranée Marseille 22-

31/05/05 ABILE Leg2 R/V , Méditerranée Nice 12-20/02/06

MISCOBA R/V L'Europe Med, Marseille 12-16/03/06

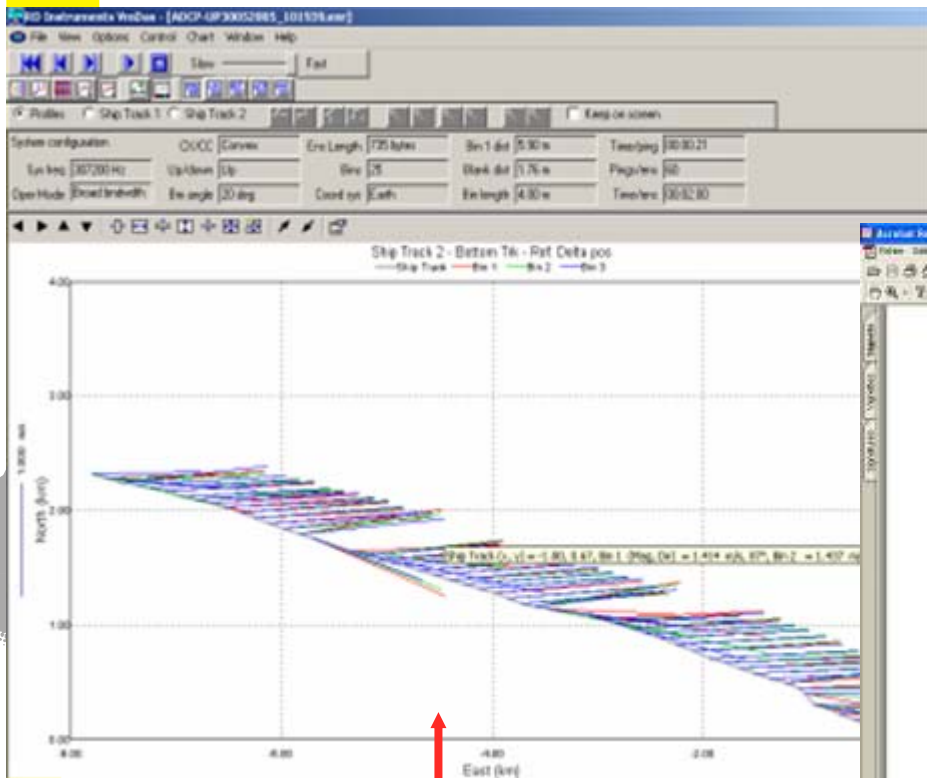
|                                  |                       |
|----------------------------------|-----------------------|
| Max distance without surfacing : | 45km                  |
| Max distance with no escort :    | 25km                  |
| Max distance in One Day:         | 60km with PhY payload |
| Max Depth reached :              | 2500m                 |
| Hours underwater:                | ~800hours             |



## Feb04-June05 64 Days at sea

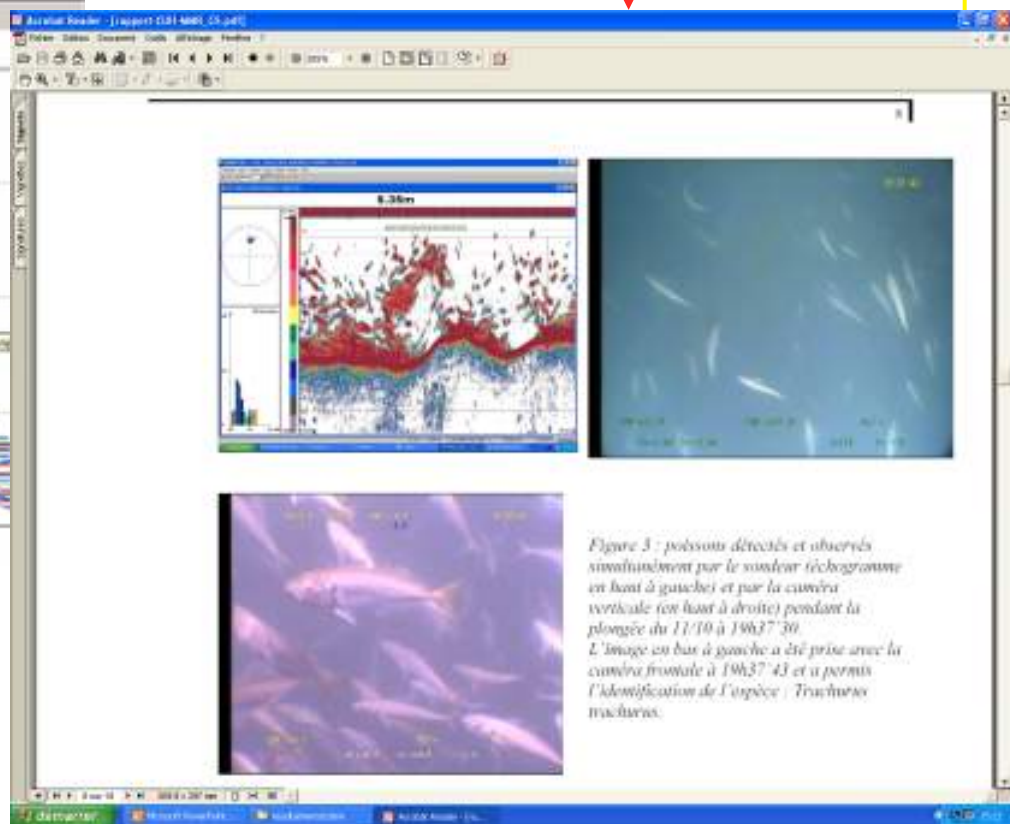
*Uptodate feedback: Max depth reached 2500m, Max distance in one dive 45km with one surfacing, Mean Operational team 3 people, Mobilisation on 5 different vessels*

EK60 Data collected  
Of Brest  
**ETHAUVAL June04**



ADCPs Data collected by  
ASTERx In Med Sea

**AUVPHY may 2005**

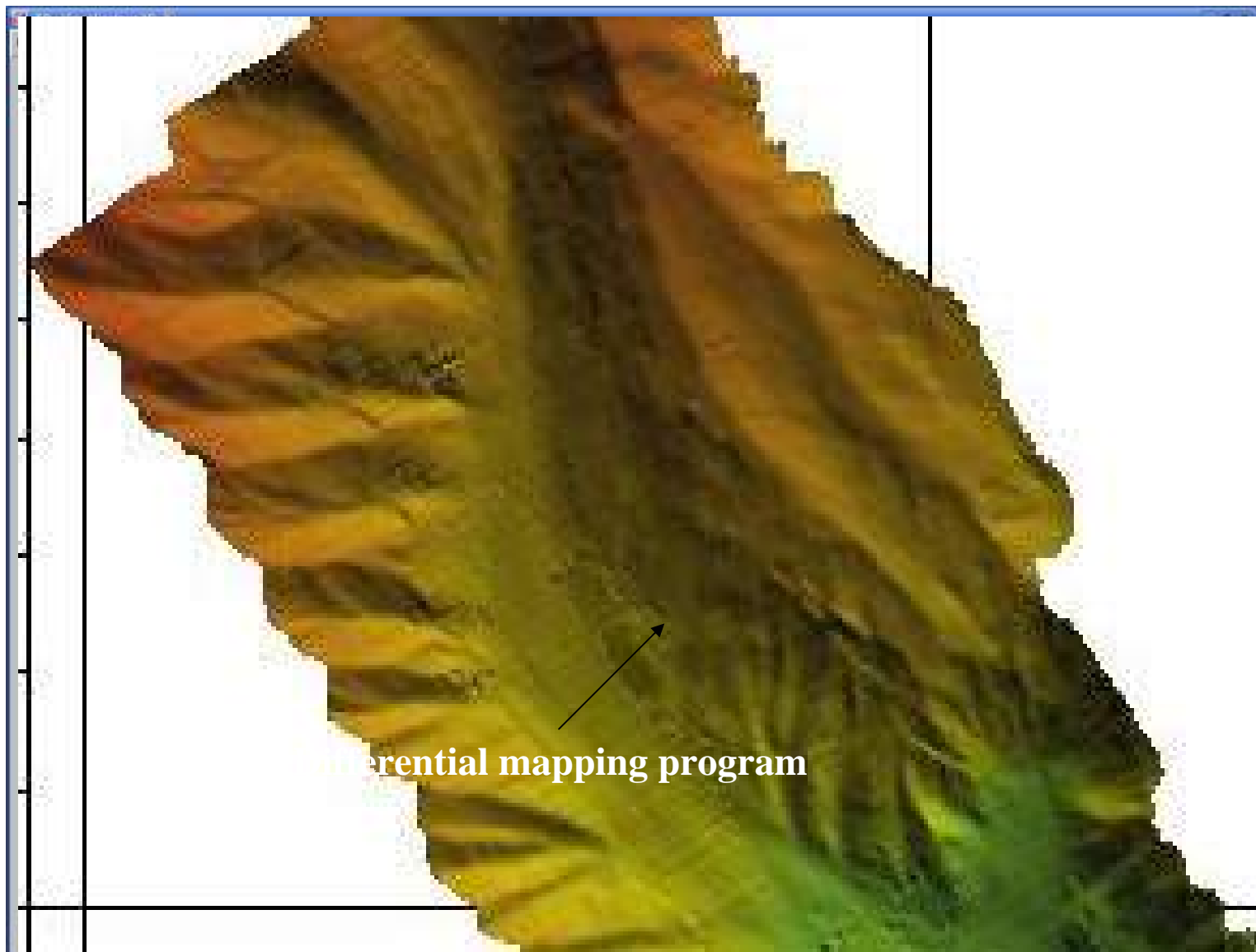


*Figure 3 : poissons détectés et observés simultanément par le sondeur échographe en haut à gauche) et par la caméra verticale (en haut à droite) pendant la plongée du 11/10 à 19637'30. L'image en bas à gauche a été prise avec la caméra frontale à 19637'43 et a permis l'identification de l'espèce : Trachurus trachurus.*

# First cruise with the EM2000 Decembre 2005 canyon du Var

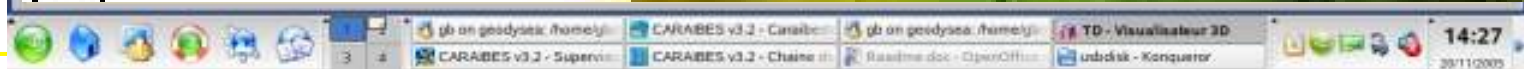


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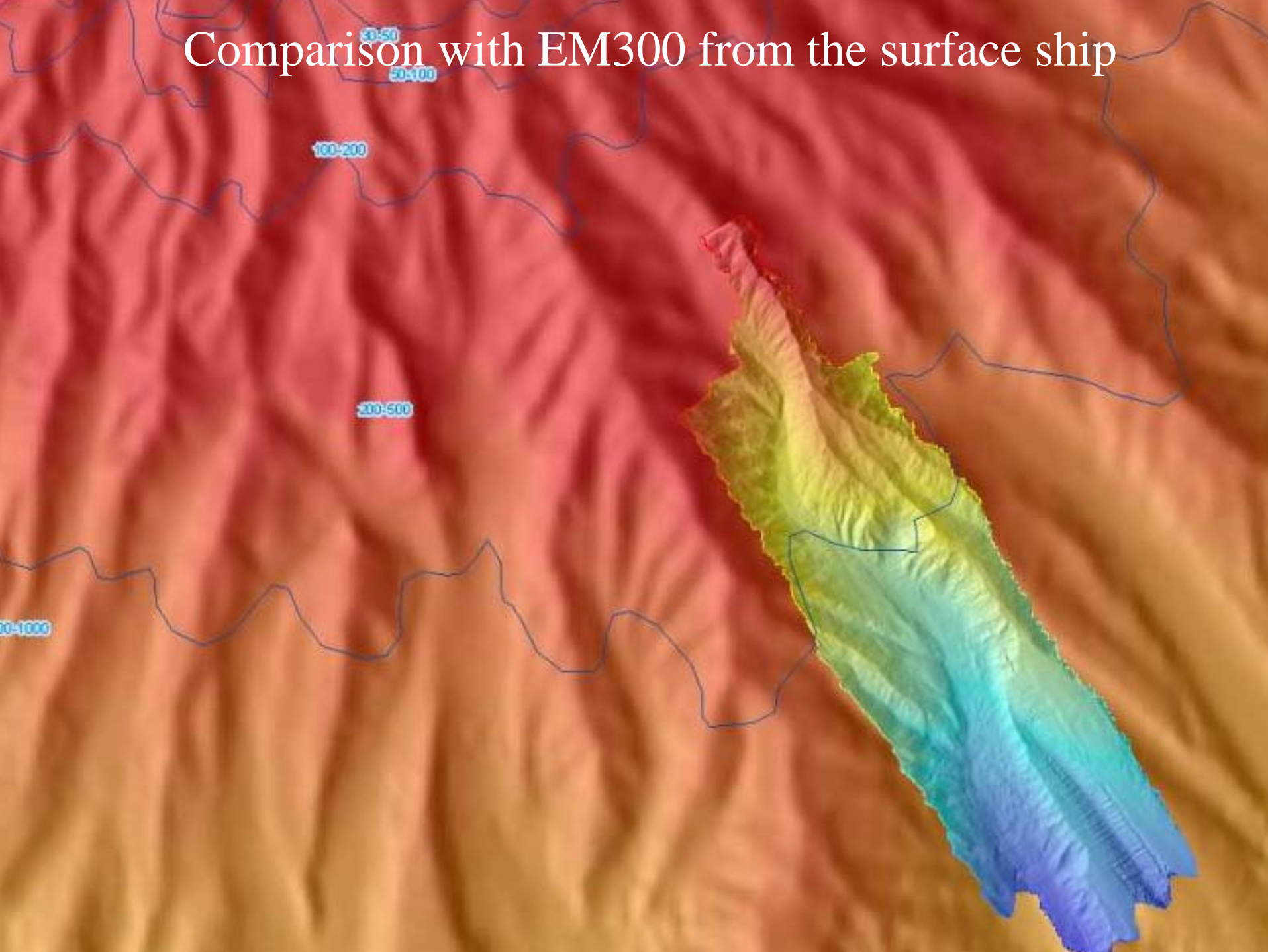


Differential mapping program

ch  
ig  
2



# Comparison with EM300 from the surface ship



ALLEGRO 05: use to cruise near Palm beaches and sunny places, but hollydays organised in « cold region » off Hegoland (tp  $-5^{\circ}\text{C}$ , for two weeks) ASTERx on Heincke AWI R/V



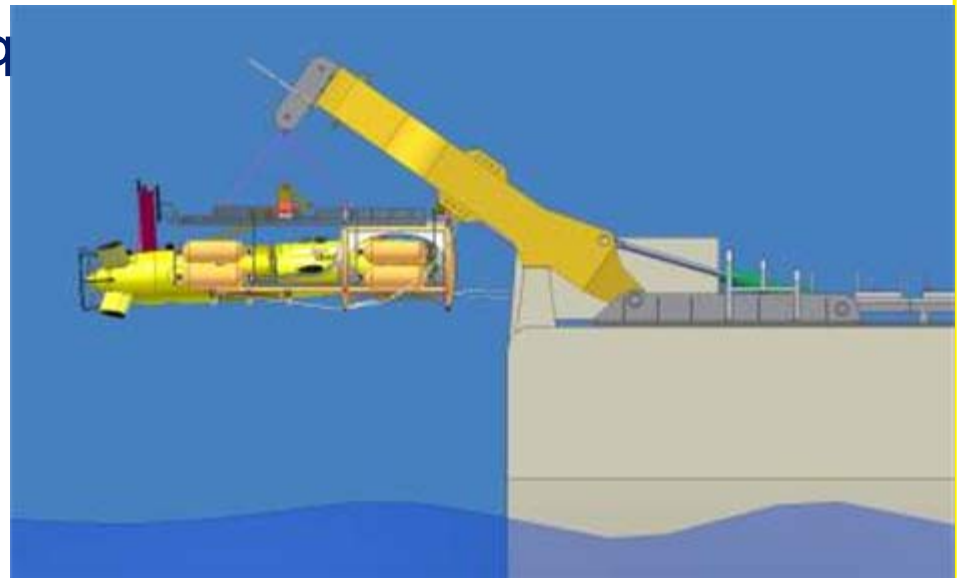


## Under pressure... of usage

- 60 Days at sea in 8 months in 2004
- 220 Days requested in 2005 !!
- BioNil on board the Meteor in 2006.

## And near term perspectives

- Second vehicle in process (IDEF<sup>x</sup>?)- In operation End of 2006
- New LARS CALYSTE®
- Payloads ...Next...New SBP
- Mission preparation soft q (MIMOSA® PSE®)...





## An Explorer (Fan) Club In 2 Years



Ifremer

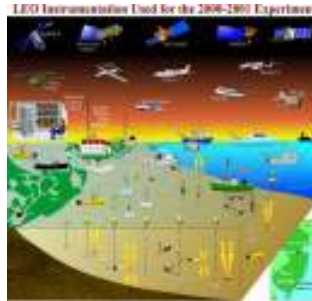
- Missisipi University (1) 3000m depth
- St Johns University (1) 3000m depth
- Bremen University- MARUM(1) 5000m depth
- Ifremer (2) with 5 interchangeable payloads
- Next ....



# Underwater Systems Synthesis



Coastal



Mobile observatories

- ROVs / towed
- Manned Sub
- AUVs
- Gliders
- drifters

Spatial / temporal

Fixed observatories

- With cable
- Autonomous

Underwater technologies

Open sea  
ESONET



Ifremer