Underwater Vehicle Systems at IFREMER

From R&D to operational systems

Jan Opderbecke

IFREMER

Unit for Underwater Systems

Underwater Systems Unit

38 permanent staff

Operational Engineering

- *Mechanical and systems engineering*
- *Marine robotics, mapping, acoustics, positioning*
- *Electronics and embedded control software*

Technological R&D

- Autonomous mission control
- Coordinated/cooperative MV control
- Image processing, mapping, classification, reconstruction
- Acoustics and positioning
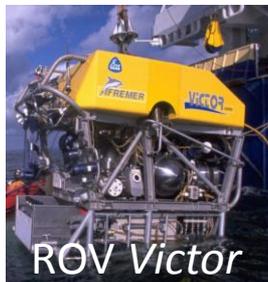- UW communication
- Innovative systems

Department for the national **Oceanographic Fleet**

National Programming Commitee for ships, u-w systems and equipement

Operating Company GENAVIR afilliated to IFREMER
- Ship & Vehicle operations
- Maintenance

Science Departments
At Ifremer, but Universities etc.

HOV *Nautile*

ROV *Victor*

HROV *Ariane*
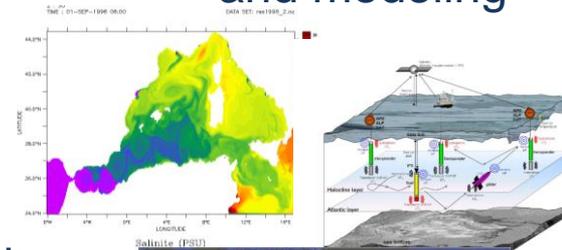
AUVs asterX & idefX

Unit for Underwater Systems

Nautile : future of HOV in Ifremer / France / Europe ?

Victor 6000 : evolution of ROV to new ways of deep-sea science

HROV Ariane : facilitate access to underwater investigation

AUV Coral: towards a mobile observatory

R&D : key technology topics

Nautile 6000m

Victor 6000m

HROV *Ariane* 2500m

AUV Coral 6000m

asterX/idefX 3000m

glider fleet

Underwater robots for ocean sciences

Ifremer

Global changes and modeling

Living resources

Mineral and Energy resources
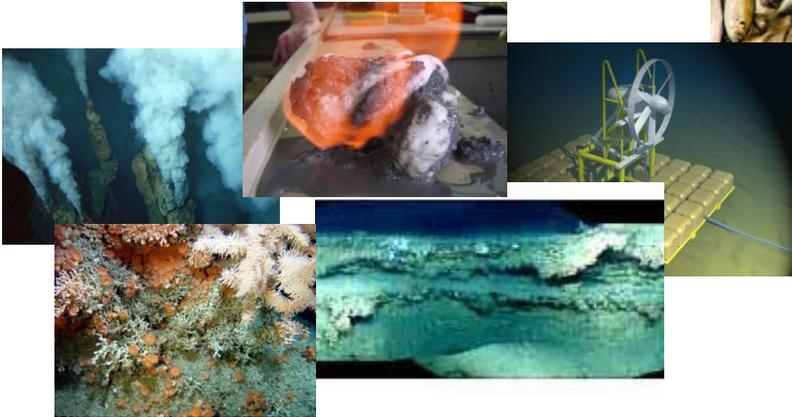
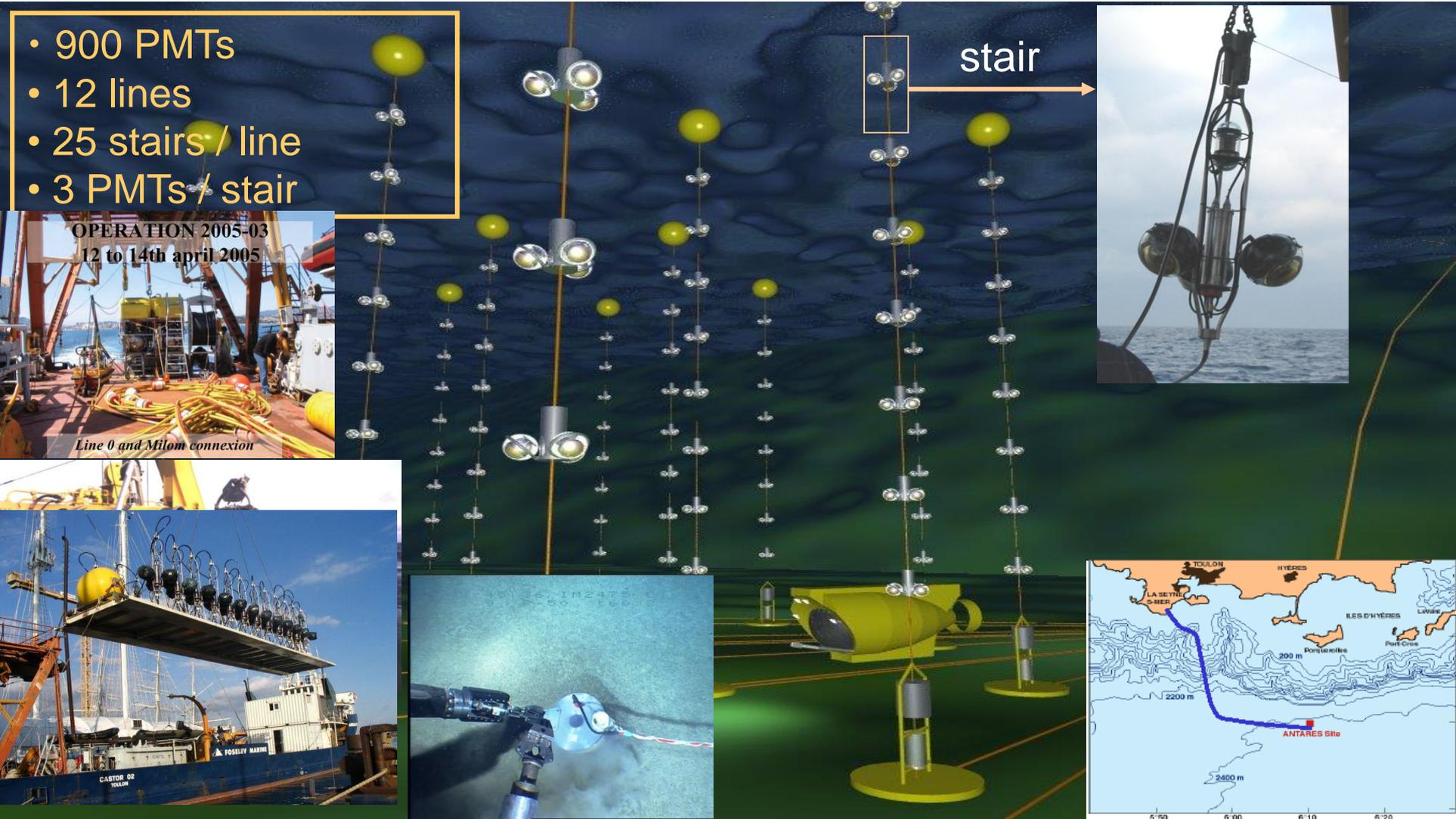Biodiversity
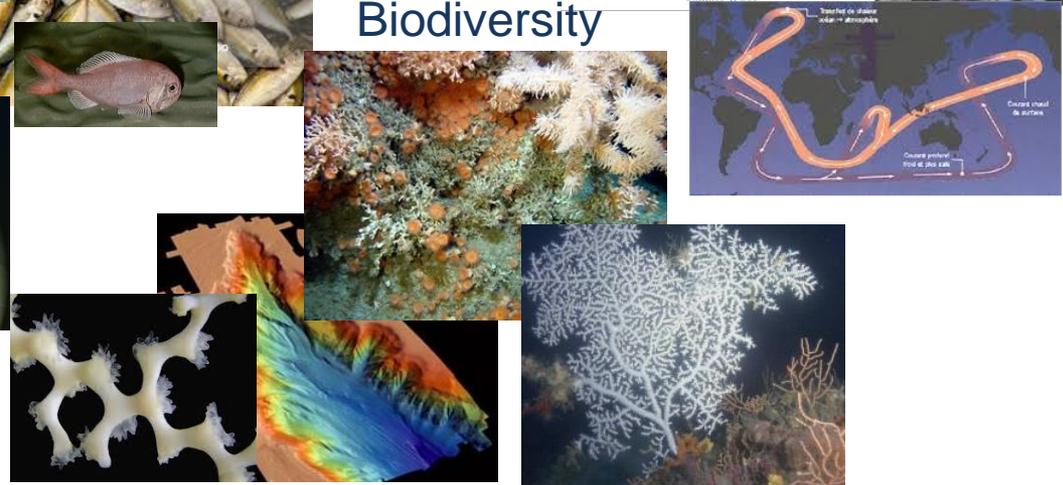
National deep sea intervention capability
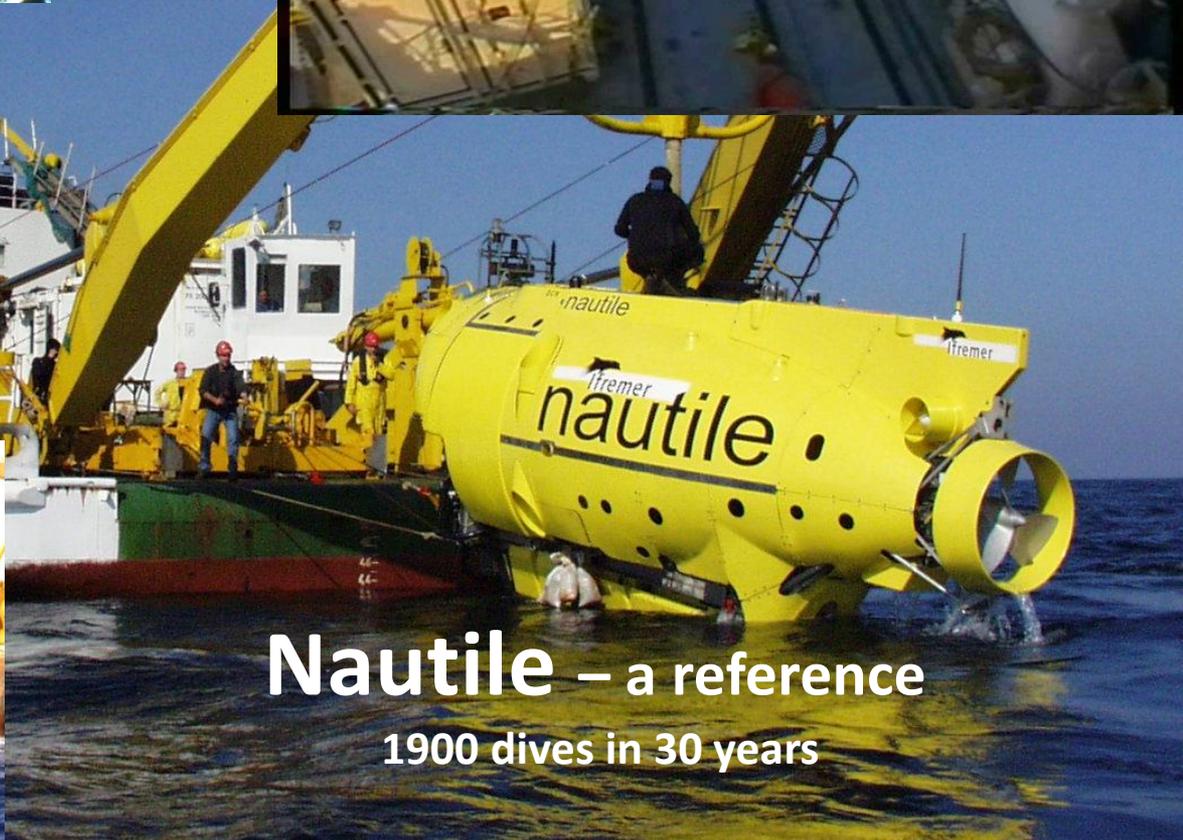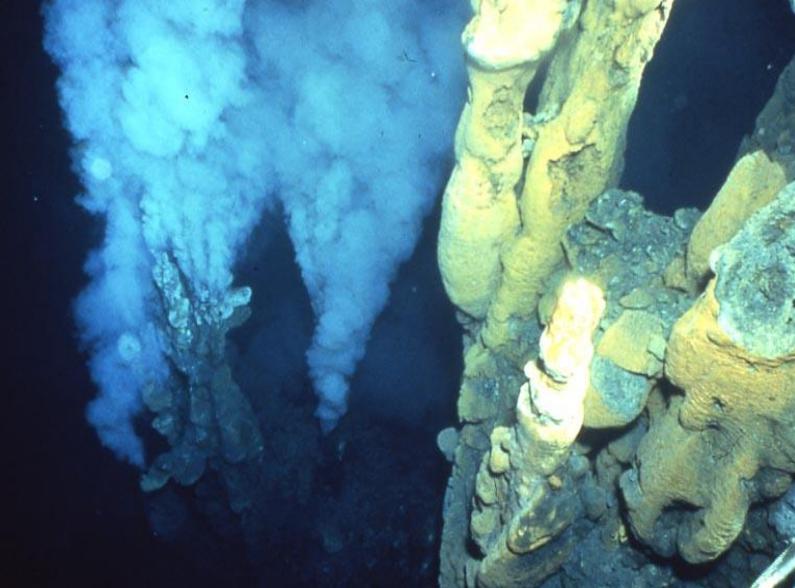BEA - black box search, "first aid" on Prestige wreck site
ANTARES & MEUST deep sea observatory (Neutrino telescope)

- 900 PMTs
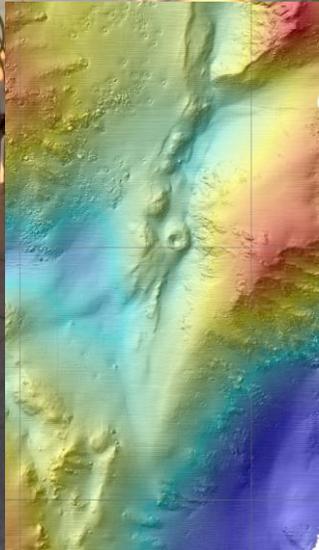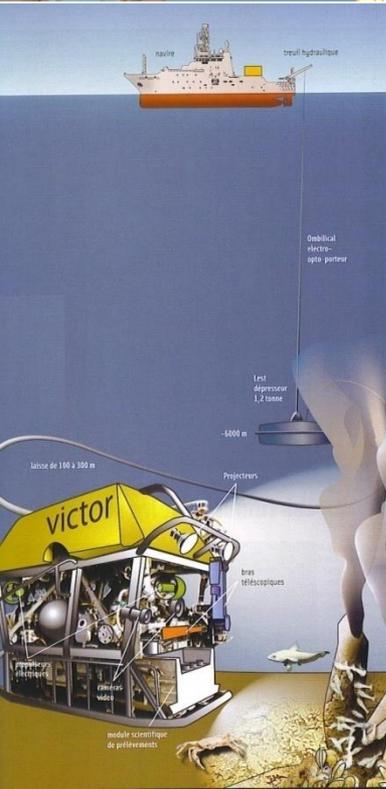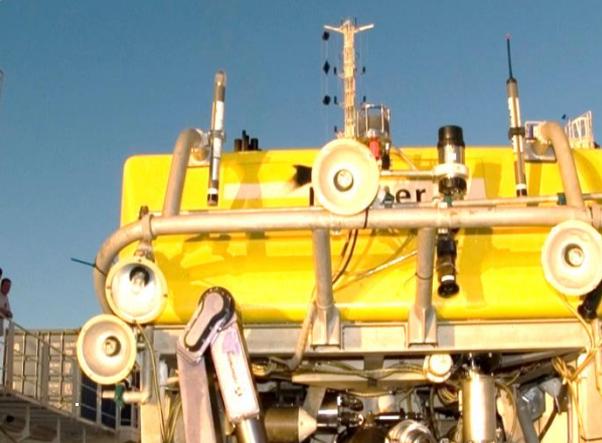- 12 lines
- 25 stairs / line
- 3 PMTs / stair

stair

OPERATION 2005-03
12 to 14th april 2005

Line 0 and Milom connexion

Nautile – a reference
1900 dives in 30 years
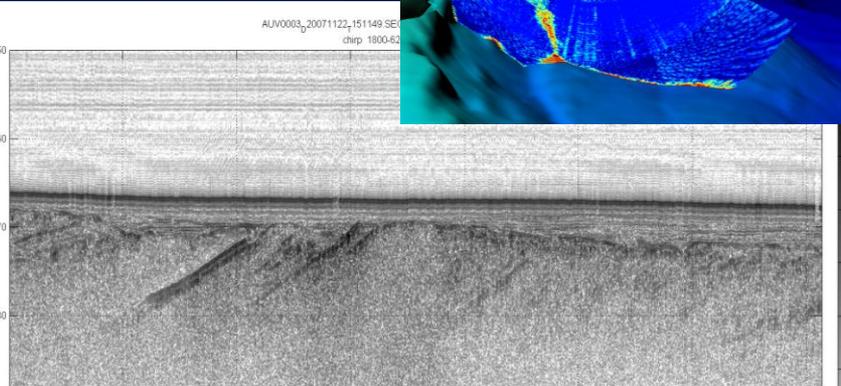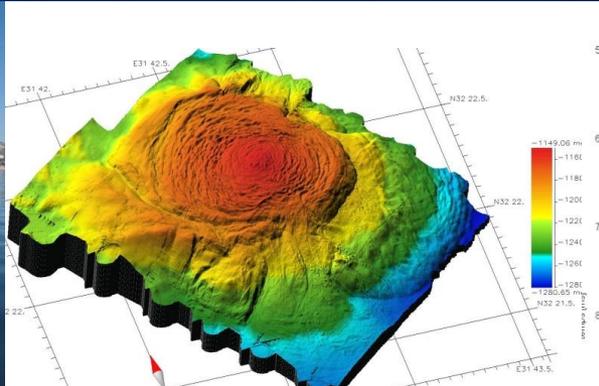
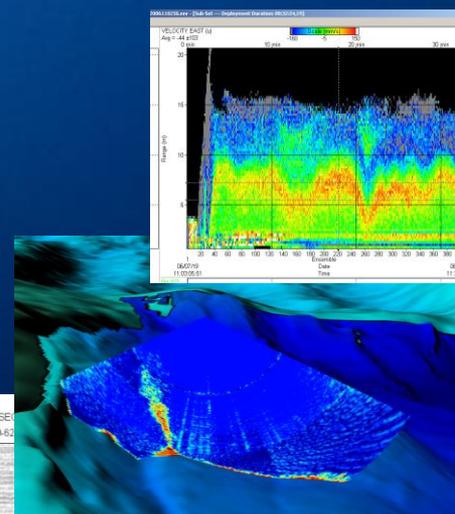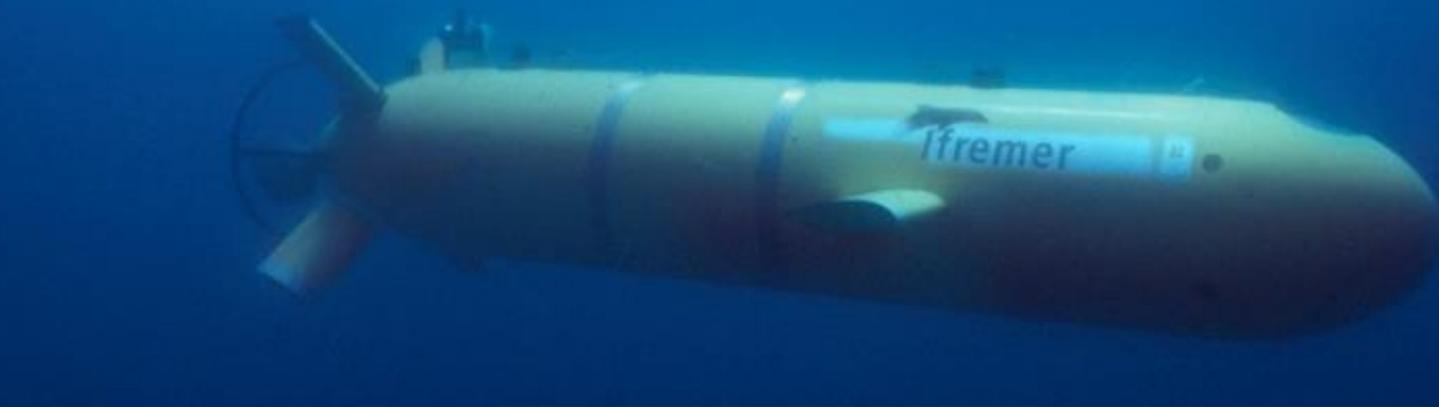Victor 6000
a workhorse for science

Autonomous vehicles AUVs asterX & idefX

open platforms for versatile usage

The hybrid ROV *Ariane*

Motivations :

- Exploration & intervention in coastal areas down to 2500m

- Deployment from small non specialized vessels

- Flexible programming related to coastal fleet, fast mobilization

- Optimized cost of operations (ship size/space, operating crew)

Design studies	*Development with industrial architect*	*Work stopped, batterie fire*	*Test cruises, commissioning*

2011   2012   2015   2016   2017

CORAL - *a new deep sea AUV in 2020*

Main features

- Long range multi-scale survey
- Close to sea-bed optical inspection (ground truthing)
- Complete data sets from multiple scientific sensors including in-situe filtering & analysis
- Target detection and detailed investigation – reactive mission strategies
- Dual use with ROV or HOV

Design studies

Development with industrial architect

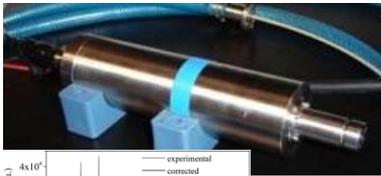*Integration & sea trials*

Test cruises, commissioning

2016

2017

2019

2020

©Ifremer / ECA Group / CORAL project

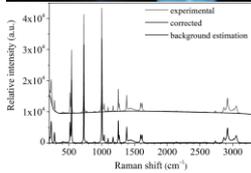# Technology topics

Mission language for enhanced autonomy ●
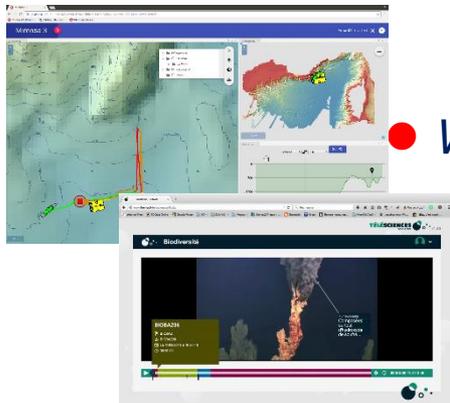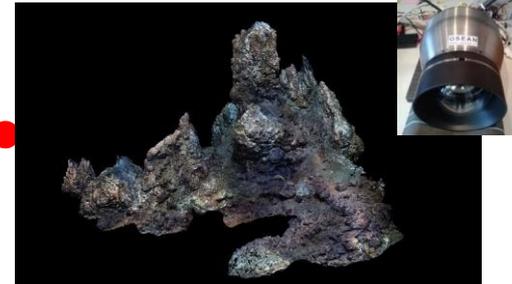
● Servicing of deep-sea observatories

High bandwidth optical communication ●
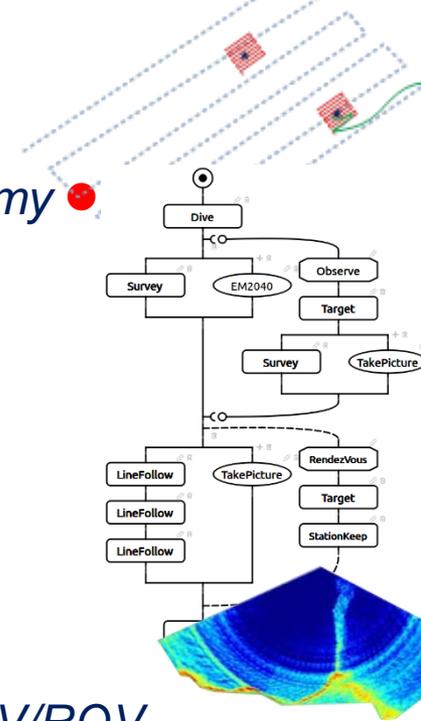
● Water sampling & in-situ analysis for AUV/ROV

Advanced imaging & processing ●
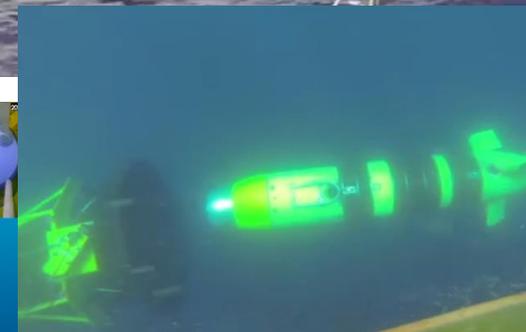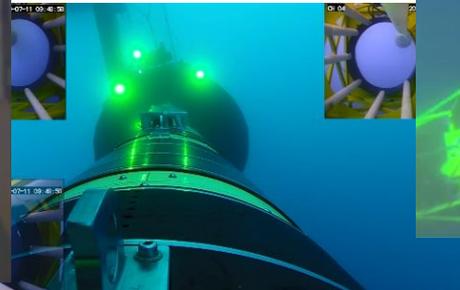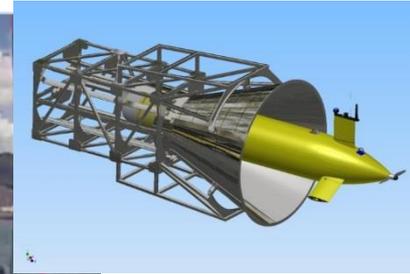
● Web-based mission management sw & tele-presence

Aided manipulation & augmented reality ●

DCNS & Ifremer : Docking of AUV under moving vessel

DOCKING in compliant structure

under ship hull

- Cooperation DCNS-IFREMER
- USBL and optical guidance
- 2 knts relative speed
- Security strategies adapted to manoeuver under ship hull
- Demonstration at sea in 2014

Advanced Communications

Opticomm : **wireless optical data transfer**

- Bandwidth 10Mbit/s :   Transmitting live video
- Range >50m :   Wireless ROV control (battery powered)
- TX angle > 45° :   vehicle-to-vehicle & vehicle-to-observatory scenarios
- TRL 7-8:   Product introduced, demonstrated in Med Sea 2015

Optical imaging and processing

– Image sensor integration and optical optimization

– Image analysys and qualification

– Functional analysis an design from sensor to processing
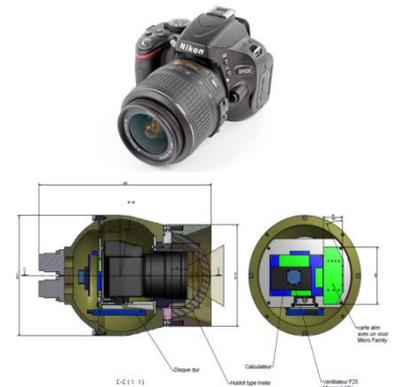
*High sensitivity
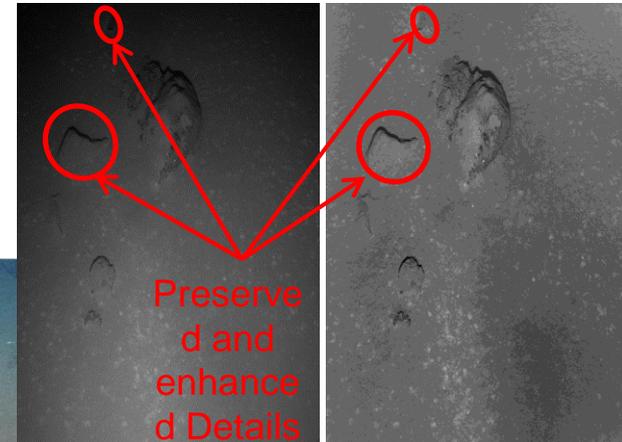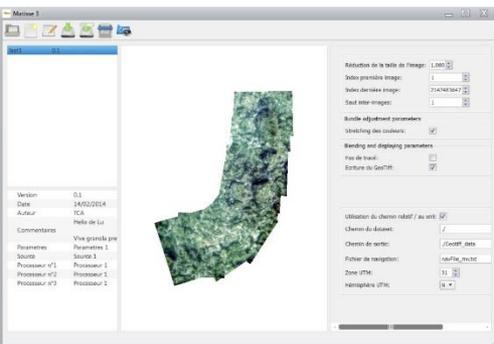still camera*
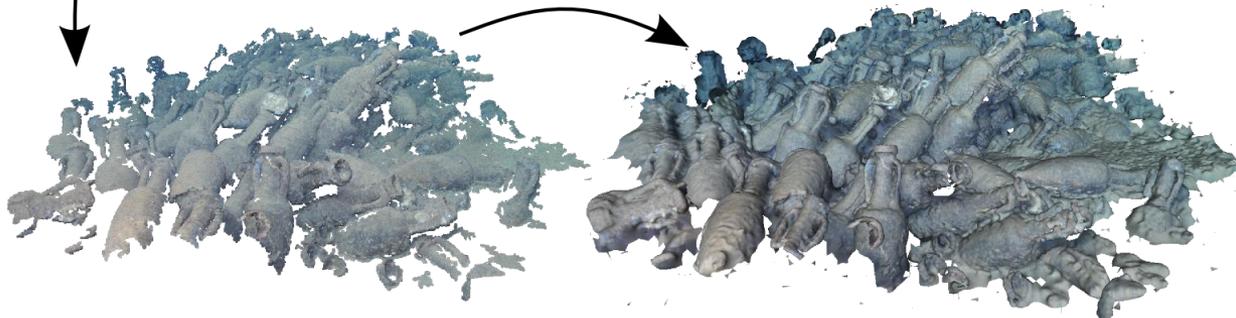
Stereo HD camera rig

HD Cameras

SLR still Camera

Image processing

- Image correction : lighting, distortion
- Image processing : geo-referenced moaïcking, monocular 3D reconstruction
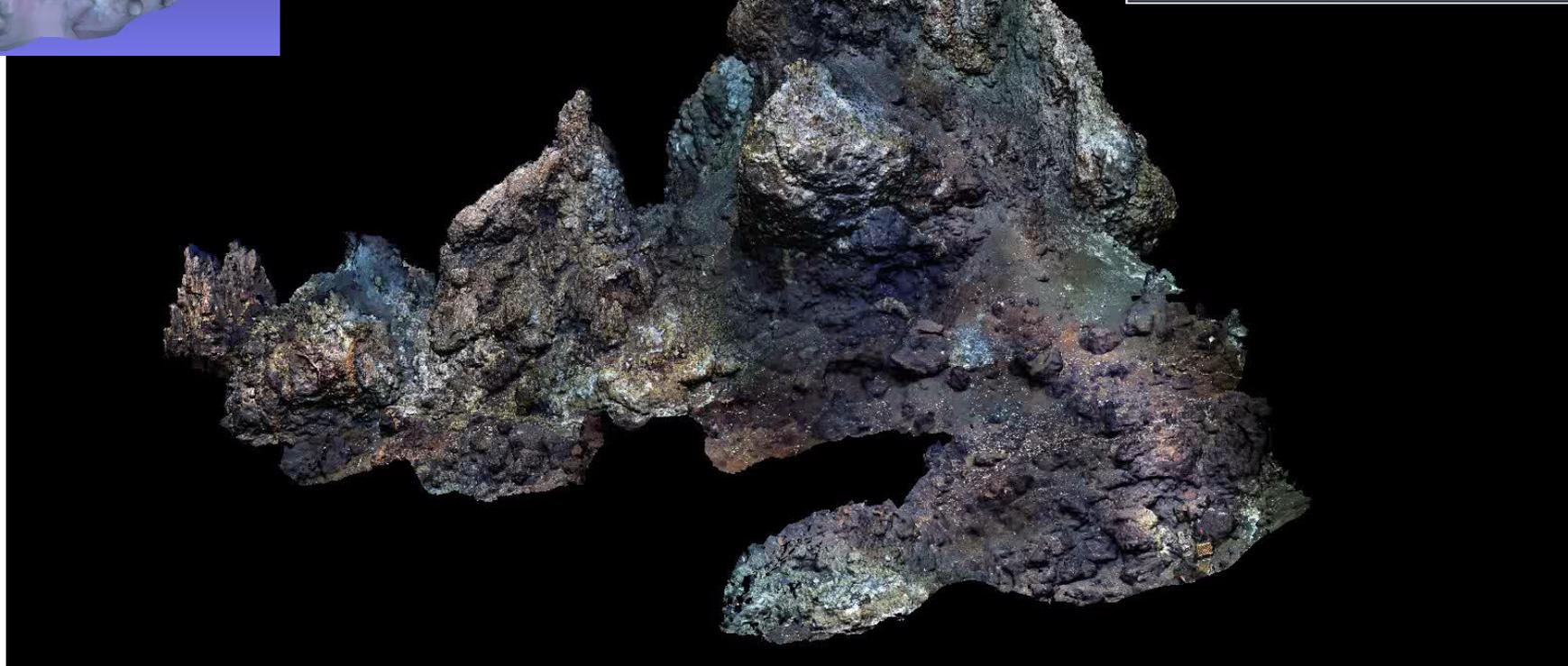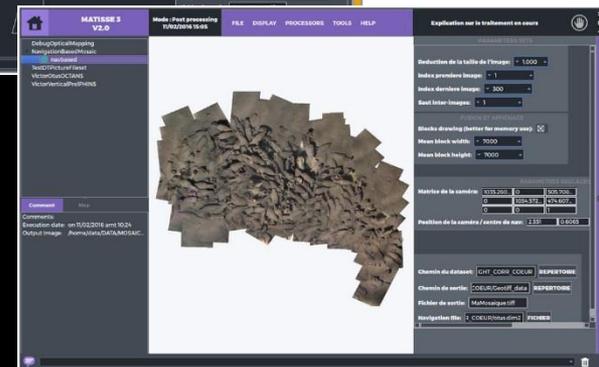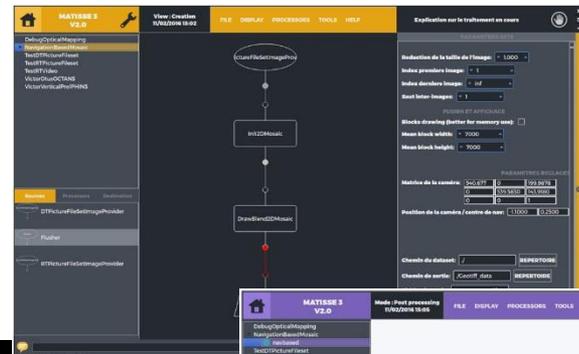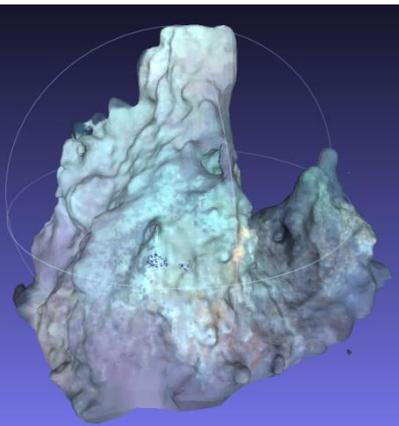- *Matisse* : operational software for optical mapping

Preserved and enhanced Details

Images to 3D points

**3D points to surface**

10 years progress in Image processing

FP7 MORPH - Heterogeneous cooperating multi-robot fleets

MORPH (finished 2016)

- Vehicle fleet (6) adapting to task & environment
- Multi-agent cliff mapping
- High level mission planning for complex tasks
- Networking acoustic communication
- Distributed navigation by range-only data fusion
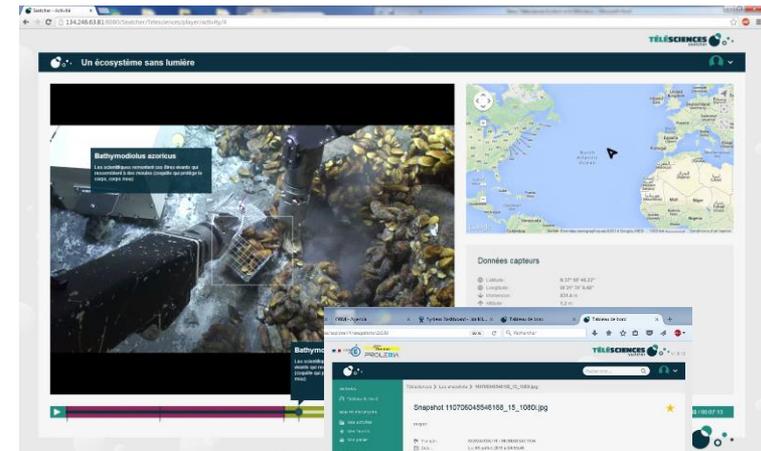- Shared modular control software (ROS)
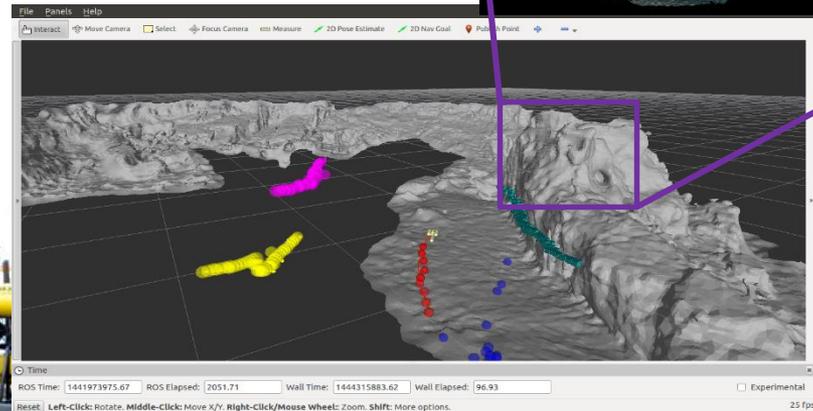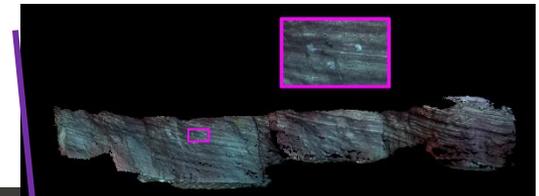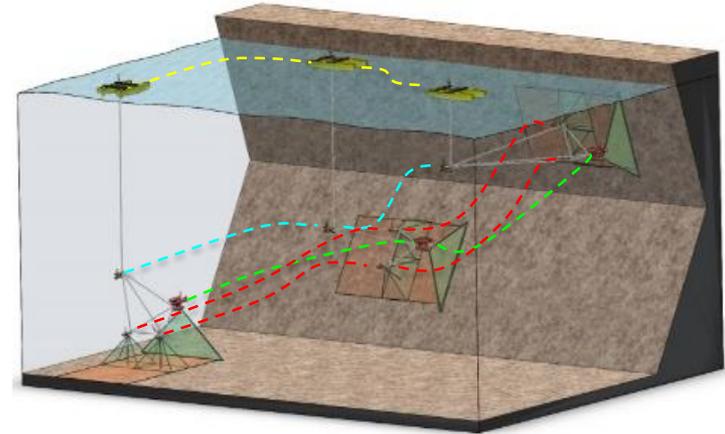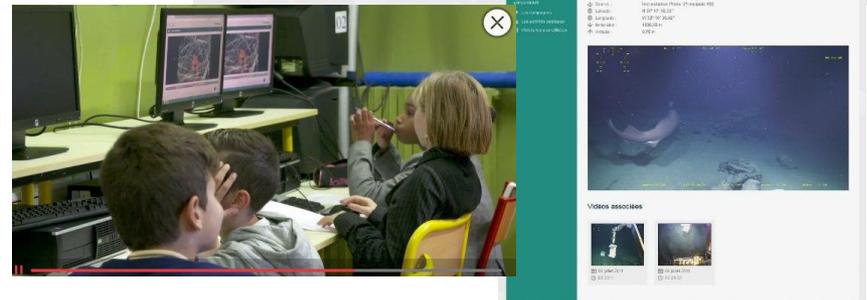
Remote mission management & cruise lab
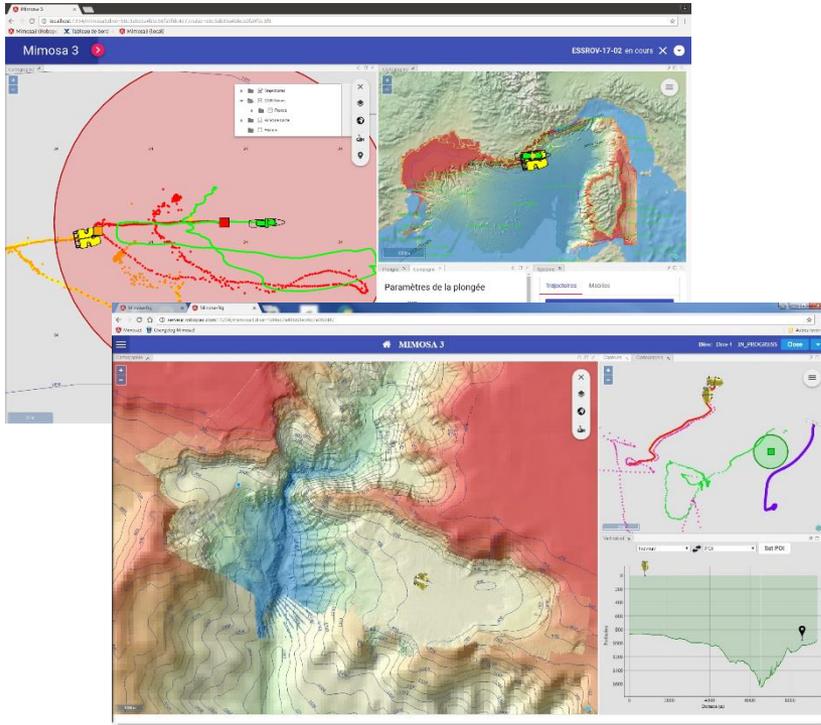
Web based mission management
- Dive planning and following
- Charts & data managements
- Unified data base accessed from vessel / shore

Remote Scientific Cruise Lab & Telescience
- Web data portal
- Smart search, visualization, annotation, analysys
- Faster assessment of data during cruise
- Augmented reality displays

Thank you !