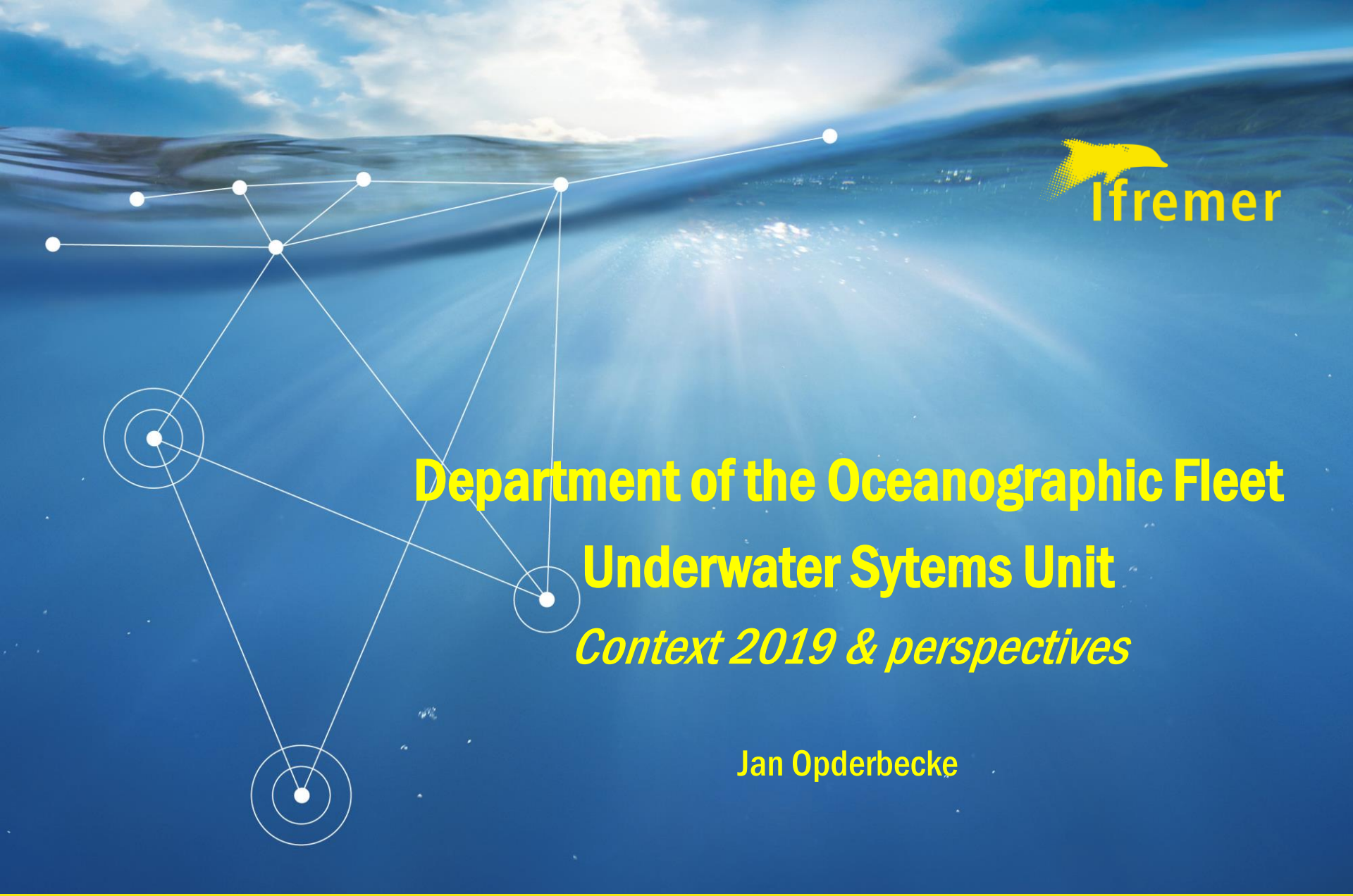
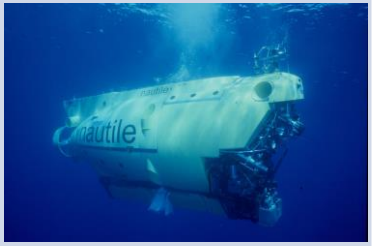
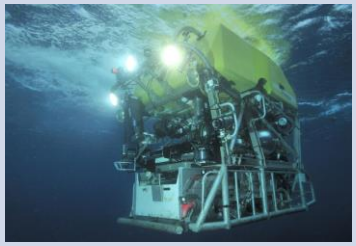


Department of the Oceanographic Fleet
Underwater Sytems Unit

Context 2019 & perspectives

Jan Opderbecke

Underwater Systems in the french fleet

Nautile	*Victor6000*	*Coral*	*Ariane*	*Aster^{X} & Idef^{X}*
 	 			 
Manned Submarine	ROV	AUV	Hybrid ROV	AUV
6000m	**6000m**	**6000m**	2500m	3000m
Since 1984	Since 1997	Objective 2020	Since 2017	Since 2005
Exploration Intervention	Exploration Intervention Cartography	Long range Survey	Exploration Intervention Cartography	Survey

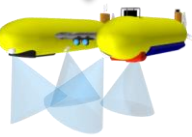
The CORAL AUV projet

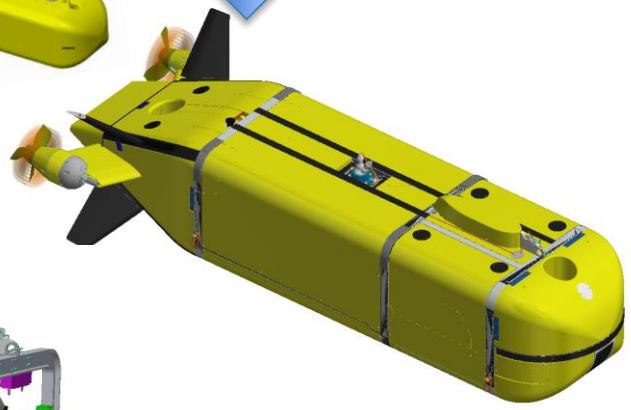
Development of a 6000m AUV

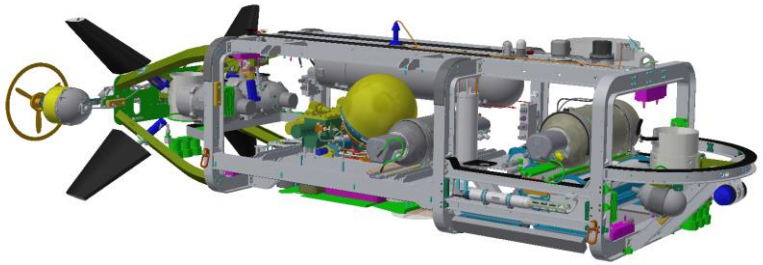
APS | CdC | AO | CONCEPTION PRELIMINAIRE | CONCEPTION DETAILLEE | FABRICATION | INTEGRATION | VALIDATION EN MER | CHARGES UTILES | DEMONSTRATION SCIENTIFIQUE

2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | ...

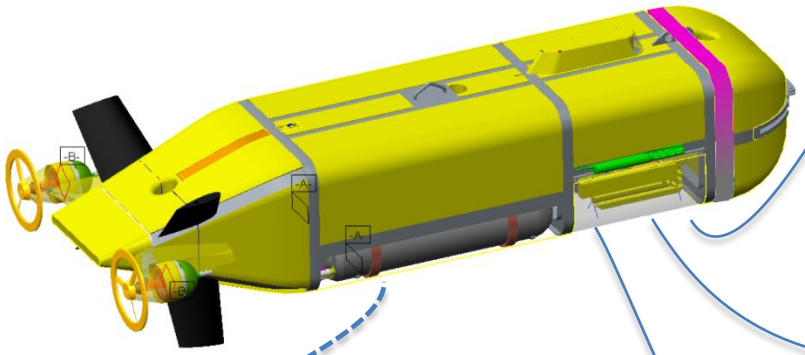
RECEPTION







AUV 6000: scientific equipement & multi-sensor configurations



Permanent equipment

- Optical HR imaging
- Multibeam sonar
- CTD
- multi-sensor hub

Subbottom profiler Echoes 5000 +

- RAMAN spectrometer **or**
- ADCP 300 kHz **or**
- Water sampler **or**
- Optical data link **or**
- Rangemeter LBL

Sidescan+SBP Edgetech +

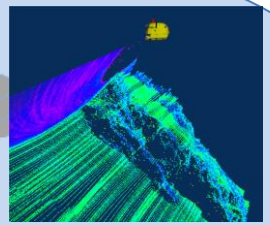
- RAMAN spectrometer **ou**
- Water sampler **ou**
- Optical data link

RAMAN spectrometer +

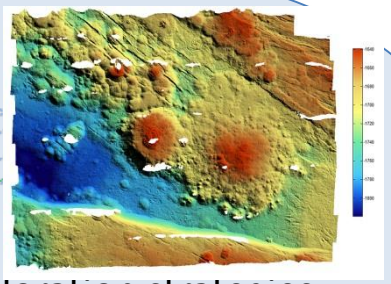
- Water sampler **ou**
- Optical data link

Coral, un avdanced autonomous system

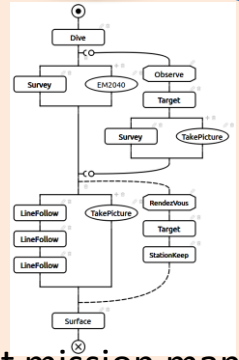
Multisensor Payload,
acoustic & optical mapping,
Scientific sensors & sampling



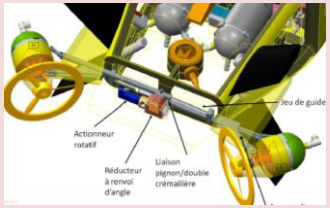
Perception
& security



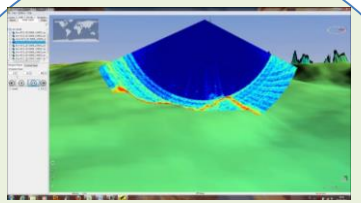
Exploration strategies
Deterministic profiles &
Event-driven actions



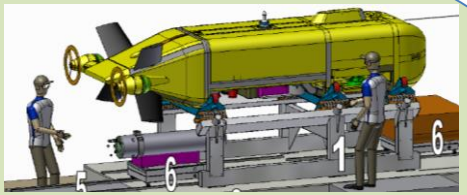
Intelligent mission management
Intelligent behaviour,
Graphic mission langage



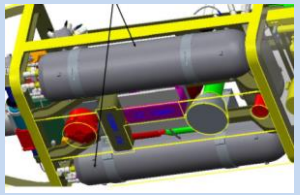
Manoeuvering capabilities
Endurance for long ra nge profiles
Zero velocity « hovering »,
Active ballasting



Onboard processing,
integrated in vehicle control



Compacity
Wide access to ship-time,
Multi-vehicle operations



Endurance
Batteries LI 28kWh

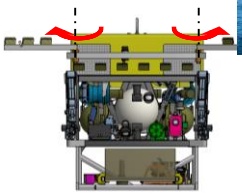
Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

UNION EUROPÉENNE
Fonds Européen de Développement Régional

RÉGION SUD PROVENCE ALPES CÔTE D'AZUR

l'Europe s'engage en Provence-Alpes-Côte d'Azur

A new deep ROV for the French Fleet



A decision of the ministry of research

- Replacement of Nautile in 2025
- Present by end 2018 a pre-project to scientific comity
- Feasibility of concept : improvement % Victor, replacement of Nautile
- State of the art, technological key points, project dimension

An ambitious goal

- A tool for the next 30 years
- New dive & operation scenarios
- … a new level of performances

Starting hypotheses

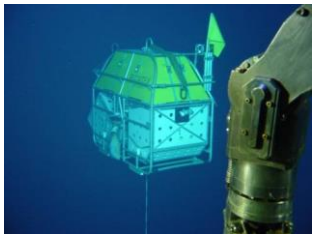
- 2 ROVs in a coherent setting within the fleet
- Continuity of services, global presence of fleet
- Efficient remote deepwater dives: cable operated system, h24/24

Victor 6000 & *Nautile* – Scientific & Operational feedback

- **Payload capacity**
  - Payload capacity limits scientific objectives and duration of the dive
  - Association of multi-instrument (e.g. in-situ analysis) with high sampling capacity needs more weight/volume capacity
  - Payload reconfigurations between dives are time-expensive

- **Sampling capacity**
  - *Nautile* : high sampling capacity but with jettisoned steel ballast
  - *Victor6000* : reversible ballast but limited sampling capacity
  - Duration of ROV dives limited by recovery of fragile samples (biology)

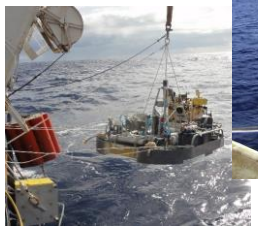
- **Vision and Perception**
  - *Nautile* : direct vision but limited to one scientist
  - *Victor6000* : on-board cameras, but actual remote perception doesn't match HOV experience



- **Remote manipulation**
  - Operations are slow, need to optimize dexterity with two 7 functions cooperating arms
  - Skill-sensitivity : need of automatic aid functions and augmented vision

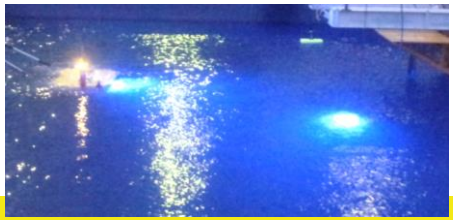
Future application domains & mission scenarii

- **Support for deployment of observatories**
  - Launch and recover observatories (up to 100kg/water) without use of drop-ballast
  - Pose and position precisely on seafloor
  - Accomplish complex tasks on observatory (seafloor servicing)
  - Deploy (light) cables on seafloor



- **Geologic Sampling & high power payload**
  - Core drilling on seafloor and ideally on slope
  - Provide hydraulic power for sampling devices
  - Pave way for future heavy power-intensive devices

- **Multi-vehicle operations**
  - Simultaneous AUV & ROV operation
  - Remote access to AUV data and mission plan (Comms rendez-vous)
  - New concepts of cabled or smart elevators



Conclusions of ROV survey

- **System Architecture**
  - Depressor are less used today
  - Direct deployment is now the most used architecture
  - Advantages of single body deployment prevail: mechanical load on cable, ease of deployment, impact on maneuverability manageable
  - Top-Hat for 6000m depth are very specific & heavy (only two ROV identified)
- **ROV size & weight**
  - Most ROVs weight around 3,5 - 4,5 tons
  - Few have a weight higher than 4,5 tons (*Victor6000* is one of the heaviest ROV)
  - Size is constraint by containerization
- **Vehicle Power**
  - Older systems *(Victor 6000)* are limited by its power supply (~20kW)
  - Recent ROVs are designed with a power around 50-75kW – based on offshore ROV technology (high thrusters, hydraulic devices…)
- **Payloads, sampling**
  - Identified payload requirement ~ 200 kg in water (*Victor6000* ~ 110kg)
  - *Victor6000* has a limited reversible ballast that optimize sampling abilities

Feasability studies : outline of performances

	Nautile	Victor6000	New ROV
Vehicle mass	18.5 tonnes	4.6 tonnes	5.4 tonnes
Depth	6000m	6000m	6000m
Maximum speed	2 knots	1.5 knots	1.5-2 knots
Weight regulation	200daN Ballast jettisoning	65daN@2Lmin	150daN@4lmin
Sampling capacity in air		507 daN	700 daN
Sampling capacity in water	200 daN	114 daN	265 daN
Payload dedicated volume	1200 litres	2700 litres	3200 litres
Remote manipulation	6fct/4fct	7fct/5fct	7fct/7fct
Hydraulic plant	<1kW	5 kW	close to 20kW
Vehicle available power		20kW	45-50 kW
Autonomy	8 h	24/24	24/24
Number of operators	8	8	8
Transport	exceptional convoy	containers	containers

Persistent Sea-floor Perception: Augmented Reality

- **Operate & Navigate in 3D environment model**
  - Integrate multi-modal data from previous surveys and from actual dive
  - Provide for actual field-of-view or environment mode
- **Situate ROV & manipulators relative to environment model**
  - Overlay accessibility diagram, model select sampling etc.
- **Provide ‘real time’ analysis and assistance**
  - Classification, detection & identification (species, sea-floor characteristics, geological phenomena)
- **Set framework for full collaborative telepresence work schemes**
  - Transmission of data & video in real time
  - Remotely interactive software, Database access

➢ **Aim : Scientist interacts with environment model (operator & vehicle become invisible tools)**