iXnews

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CANOPUS
Taking LBL to the next generation

DRIX
USV for high seas operations

AMERICA'S CUP
iXblue at the heart of sailing's greatest race

MH370
On the hunt for missing flight with Delph Software

A dream is spreading through the hydrographic, scientific, survey and subsea construction community – to explore new fringes of the ocean, to build structures at greater depths, to measure and monitor wider regions of the world so that the seas and oceans become a resourceful place for sustainable development on earth.

What company or scientific institute doing operations at sea is not seeking to extend the range of possibilities? What technology company has not been asked by its customers for new solutions to go deeper, to perform faster surveys, to improve the precision of measurements and images and to solve new challenges in unknown territories?

All of this in a very demanding environment where there is a strong need to automate operations, to make them simpler and safer, while keeping costs to a minimum.

This dream is as big and as complex as the dream to explore other planets in the solar system. Three things result from this.

New technologies have to be developed to bring about change and new possibilities. Complementary technologies have to merge to provide global solutions where each separate technology can only provide part of the answer.

In order to bring stronger benefits to operations, existing technologies and systems have to be operated, customized and adapted in partnership with those who are using them on a daily basis.

A revolution has to be brought about by all companies and scientific institutes that are cooperating and sometimes competing beneath the surface of the sea, so that all the various skills needed can be used to reach a common goal: inventing and offering new innovative solutions.

> “THIS DREAM IS AS BIG AND AS COMPLEX AS THE DREAM TO EXPLORE OTHER PLANETS IN THE SOLAR SYSTEM.”

At iXblue we believe that this dream is within reach and that we can play a role to help make it happen. We believe that commitment to our customers, strong support of their operations, continuous innovation and an open culture, both internally and externally, are the keys that need to be used and further developed.

I hope that reading the following pages will give you a glimpse of what we are doing at iXblue and that they will help you understand the way we think and how we strive to build this dream together. I am looking forward to meeting with you so that we can exchange on your needs and our solutions in order to build new cooperation for the future.

Happy reading and enjoy the show!

Fabien Napolitano
Chief Operating Officer

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01

NEW PRODUCTS & SERVICES

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USV for high seas operations

SEAPIX
New sonar for seabed classification

ENERGY CIRCLE
New training and services offer

CANOPUS
Taking LBL to the next generation

DRIX, AN AUTONOMOUS SURFACE VESSEL

EXPANDING THE TRADITIONAL RESEARCH WORKING DOMAINS

Two years ago, the Sea Operations division of iXblue in Australia, was considering biding for a very important seabed mapping contract in the southern hemisphere. Given the competition, their only choice was to include an unmanned solution in the asset organisation they replied with. It soon became a company-wide topic, and iXblue started to benchmark existing over-the-shelves products. No suitable solutions were found, iXblue decided to move forward and design its own product, true to the company's tradition of vertical integration, to fulfil its needs: finding a cost-controlled surface unmanned solution, reliable and truly multipurpose, in order to be in a position to gather IHO grade data on the very first try and work longer than existing assets, while also being able to work on the data in real time.

According to Sébastien Grall, Head of the Shipyard division, "two main axis led the initial design: to provide the best possible environment for the sensors, and to minimize the use of energy the platform had to produce to sail, in order to reallocate it to the payload. Those two key success factors were only achievable by getting rid of the human reference in the design." DriX revolutionary shape thus results from a number of decisions taken to make the best of hydrodynamics, whilst preserving data quality at all times.

▲ DriX in operation with iXblue survey vessel FeliX - Dieppe (France)

DriX can sail between five and ten days depending on the environmental conditions, at speeds ranging from two to fourteen knots, with a 250L gas tank, offering an exceptional seaworthiness. The payload is embedded within a gondola, bolted onto a 2 m deep drop keel that is retractable for logistic purpose, when DriX enters its Launch And Recovery System (LARS). The gondola is protected both from the bubbling effect (the creation of bubbles due to the bow's slamming effect), and from the vibrations and from the vessel's own noise. Third-partly friendly, DriX can be used with one's own already available sensors. iXblue will then tailor craft the gondola to embed the aforementioned payload antennae.

But the whole point of an unmanned solution is not to only remove the human factor on-board the asset. With DriX, a "crew" of two people is enough to pilot (if remotely operated), monitor, take care of the survey data, replenish, hoist on-board or lower into the water, and maintain the vessel. This is possible thanks to a proper LARS which is used to lower DriX into the water from any kind of vessel fitted with the proper lifting equipment and also acts as a floating dock to receive DriX. The replenishment from the LARS, as well as a back-up data retrieval and an engine-oil servicing functions are currently under development. And the icing on the cake: both DriX and its LARS can be deployed overseas using a mere 40 feet container box.

As far as operations are concerned, DriX can carry any type of equipment, providing that its antennas fit into the gondola and that its electronic cabinet fit into the main hull. It is employable for any type of applications needing to have an enduring, offshore-going and stable surface asset to work from.

With DriX, iXblue is initially targeting the Geosciences and Energy markets. The company is also ready to provide the platform to specialized integrators for defense applications.

DriX

UNMANNED SURFACE VESSEL

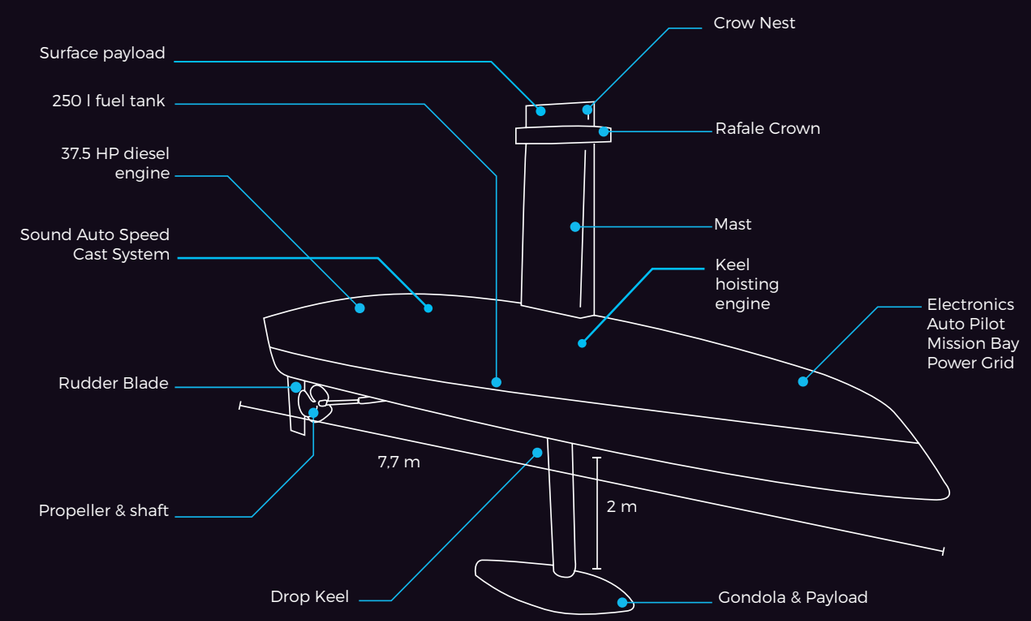
Features
- Design optimized for both coastal and offshore missions
- Removable and replaceable gondola
- Launch And Recovery Systems (LARS) included

Benefits
- Excellent platform stability up to sea state 4+
- Excellent manoeuvring capabilities and a wide range operational speeds (from 2 to 14 knots)
- Unmanned architecture providing an extended working domain
- Long endurance (ranging from 5 to 10 days)
- Reduced fuel consumption

Specifications
- Control: fully autonomous, semi-autonomous, direct remote control
- Communications: line of sight (WIFI, radio, contact us for SATCOM)

Applications for survey operations
- Hydrographic survey
- Coastal and harbour monitoring
- Hydro acoustic survey
- Seabed mapping
- Seabed automatic classification
- AUV tracking with USBL

Applications for subsea operations
- Box-in of seabed transponder arrays
- ROV tracking for Touch Down Monitoring (pipe and cable laying)
- AUV tracking and control/ command
- Ultra-deep tow fish tracking



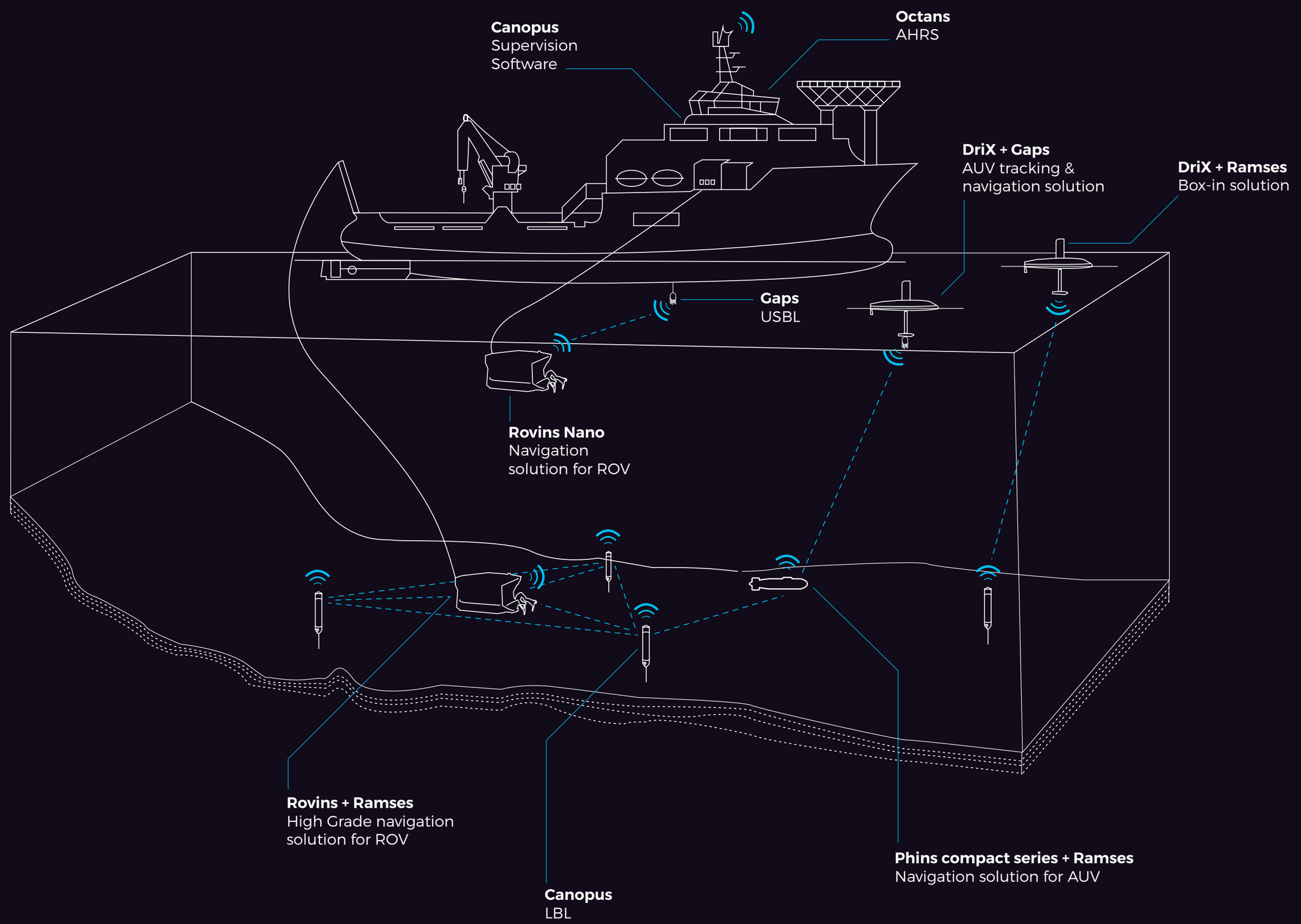
CANOPUS

Taking LBL to the next generation

Since its creation, iXblue has always put forward different approaches to address positioning issues, and subsea positioning in particular, combining innovative concepts, proprietary technologies and solutions that aim to make its products easier to implement and use, affording substantial savings. A full range of recognized and well-known products is now available, all offering the iXblue «touch»: performance, unique features, unrivaled ease of implementation, perfect cross-integration, and compatibility with third-party products.

Take, for example, Gaps, the first USBL to incorporate an INS, which gives it unique features and characteristics, or Ramses and its Sparse Array / SLAM operating mode, or again iXblue's comprehensive range of Fiber-Optic Gyroscope (FOG) navigation systems. Some of these products have indeed become industry standards, emulated and sometimes even copied.

In order to enhance its offer and be in a position to provide a more global response to the requirements of its customers, iXblue needed, for one, to take things a step further with its acoustic offer, and also to add a system layer to ease the management of all products deployed for a given application. An ambitious project was launched as a result and 01 2018 is the perfect opportunity to reveal the first elements of this new global subsea positioning system developed by iXblue.


Canopus
Supervision
Software
Octans
AHRS
DriX + Gaps
AUV tracking &
navigation solution
DriX + Ramses
Box-in solution
Gaps
USBL
Rovins Nano
Navigation
solution for ROV
Rovins + Ramses
High Grade navigation
solution for ROV
Canopus
LBL
Phins compact series + Ramses
Navigation solution for AUV

CANOPUS

The iXblue family of acoustic transponders welcomes a new member in the shape of the Canopus beacon, which takes the range to new peaks of performance and ease of use and opens up a vast fields of new applications in the area of subsea positioning.

New features include the introduction of inter-beacon, but also inter-product acoustic communication, the addition of integrated environmental sensors (P, T, SV, attitude, etc.) data recording capability, the capacity to be interfaced with an external sensor, a very significant increase in battery life, which is even longer if Sparse Array mode is used, the unified iXblue user interface with WiFi, and many more features to be implemented over the months to come thanks to a modern, scalable electronic platform common to various iXblue products.

RAMSES

To get the most out of Canopus, the other components of the positioning system are also being upgraded.

The new generation of Ramses built on this architecture benefits from the latest developments iXblue is working on, and therefore offers the inter-product acoustic communication capabilities, the environment sensors which may be necessary, and the entire range of new features developed for Canopus (iXblue WiFi user interface, recording, power management, etc.).

A complete and flexible LBL solution also makes its appearance, enhancing the Sparse Array mode which was already made very popular by the previous version of Ramses.

Gaps USBL system itself has benefited from the telemetry functionality since the release of its latest software pack (#8).

SUPERVISION SOFTWARE

A positioning system becomes increasingly complex to manage as the number of products of which it is made up grows. Determined as always to make its products easier to implement and to offer customers a genuine system-based approach, iXblue had to provide an answer to this key user requirement and offer a tool which is truly fit for purpose. The result is the Canopus Supervision software. It is built up of different operational modules as follows, accompanied by a set of tools which provide the operator with assistance throughout the project lifetime:

Prepare your mission with Canopus Software

Plan
Prepare the job (how many TP's, where, expected performance, etc).

Deploy and calibrate
Configure and calibrate.

Operate and monitor
Produce QA/QC, reach expected performance. Raise alarms.

Post-process
Improve performance and additional QC.

Canopus

LBL AND SPARSE LBL INTELLIGENT TRANSPONDER

Features
- Long BaseLine positioning
- Sparse array positioning
- USBL positioning
- Acoustic data telemetry and modem
- Embedded user interface (MMI) through WiFi wireless communication link
- Standard environment sensors including: pressure, temperature, inclinometer

Benefits
- Low power consumption
  - listening life > 2 years
  - operation life > 1,000,000 pings at maximum sound level
- A few hundredth unique wideband address codes
- Medium frequency band and omnidirectional transducer head

Mechanical
- Housing aluminum alloy with hard anodizing
- Weight (air/water) in kg: 28/16
- Size (ODxL) in mm: 180x1060
- Depth rating: 4,000 m standard (6,000 m in option)

Compatibility
- Gaps
- Ramses
- iXblue INS
- Third-party acoustic systems
- In option: SV sensors, Paroscientific™ Depth Sensors

Ramses

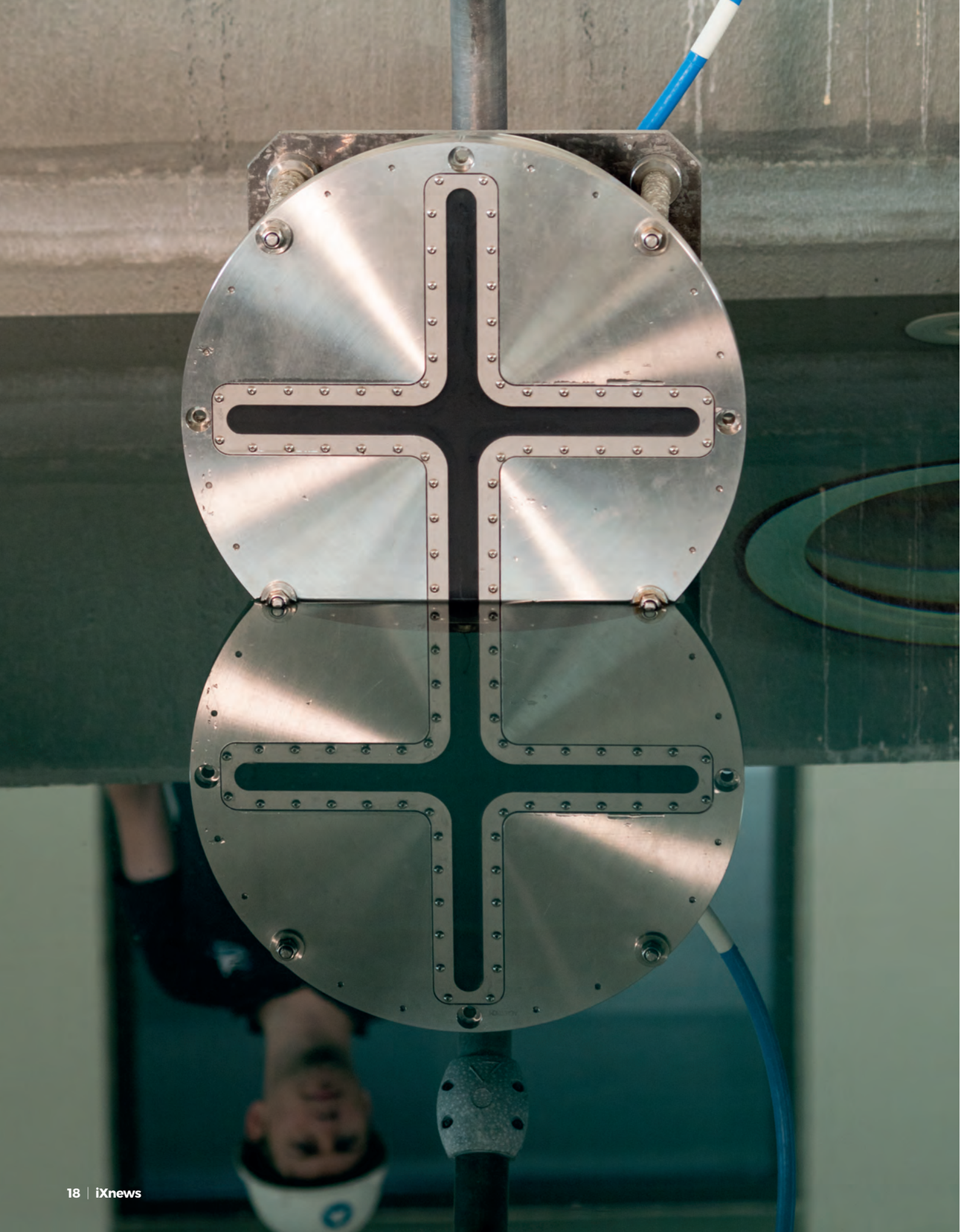
LBL AND SPARSE LBL INTELLIGENT TRANSCEIVER

Features
- Two versions available
  - A medium frequency (MF), suitable for most positioning applications
  - A low frequency (LF) for ultra long range applications
- Designed for sparse LBL and full LBL
- Usable either as a stand-alone product in a gobal iXblue positioning solution

Benefits
- Acoustic transceiver with self-contained computing
- Smooth integration for ROVs and AUVs
- LBL navigation accuracy with reduced arrays and superior precision
- Flexible array deployment
- High speed acoustic communications

Mechanical
- Housing: aluminum for MF, and titanium for LF
- Weight (air/water) in kg: 16/6 for MF, and 11/5 for LF
- Size: (ODxL) in mm: 180x730 for MF, 126x505 for LF
- Water depth: 4,000 m for MF, and 6,000 for LF

Compatibility
- Gaps
- Canopus
- iXblue INS
- Third-party acoustic systems



SeapiX sonar in pool - La Ciotat facility (France)

NEW FEATURE FOR SEABED CLASSIFICATION

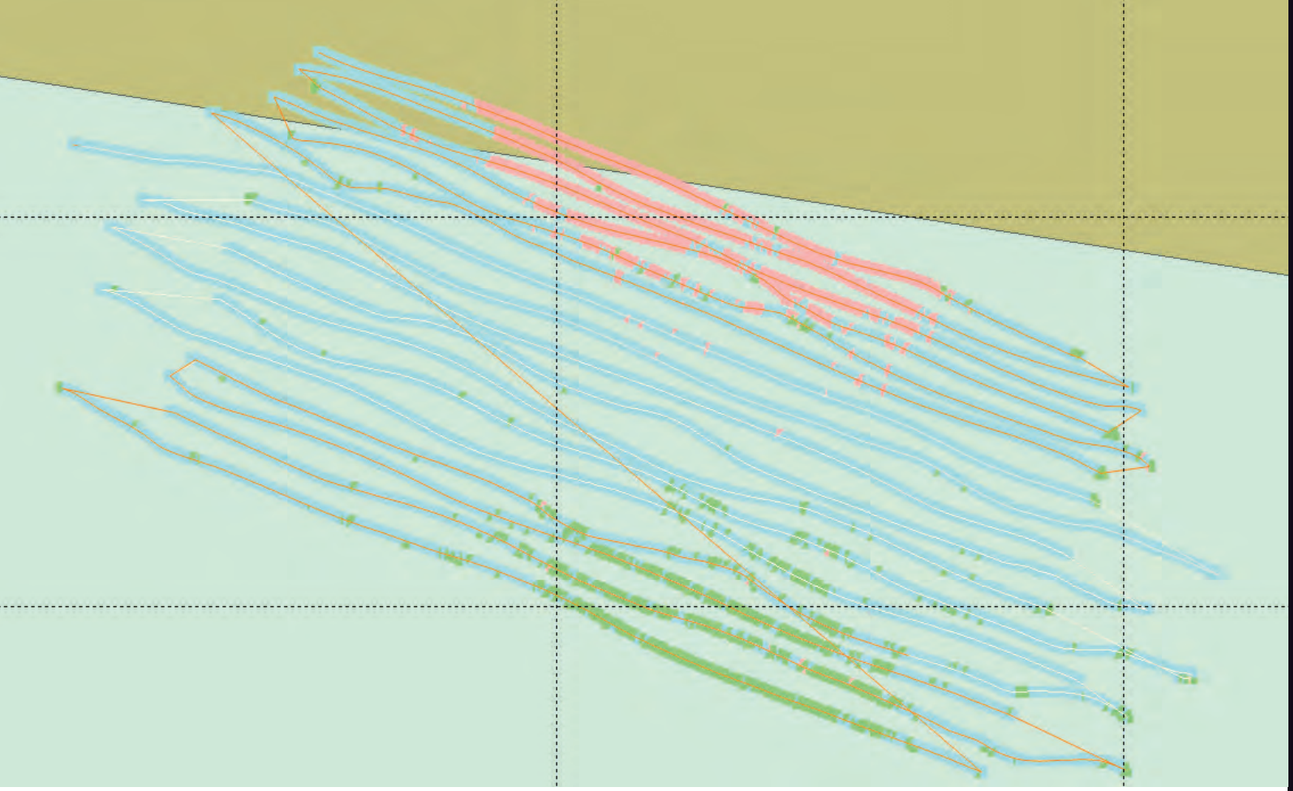
SEAPIX SONAR

Launched in 2013, SeapiX, the first compact civilian system comprising a dual Mills Cross multi-beam sonar transducer, went through multiple changes to meet iXblue's customers evolving needs in various fields of applications. Its latest "seabed classification" feature will offer will offer all players working in fishing, ocean sciences, subsea construction and maritime security a new revolutionary tool to help them achieve their operations in the most efficient way as possible.

Based on advanced technology and scientific expertise and inspired by sonars used in defense applications, SeapiX is special in that it is equally efficient in terms of volume as in terms of metrology. Using a symmetrical double multibeam, the system is able to describe the information contained in a large volume of water. By generating one or more scan swathes along or across the vessel axis, SeapiX provides total three-dimensional coverage of the water column, a bathymetric profile of the seabed and a sediment identification analysis.

«SeapiX can describe the content of a volume of water up to 200 times greater than a standard sonar can in an identical analysis period." explains Christophe Corbières, Business Development Manager at iXblue. "In addition to its ability to analyze a large volume of water, the system is also an extremely reliable and efficient metrology solution for bathymetric operations and seabed classification. The resolution of the images obtained is very high: a voxel at 100 meters depth is equivalent to 0.6 cubic meters, compared with 30 cubic meters for conventional seafloor sounders. Moreover, the SeapiX sonar has the advantage of being fully stabilized by its integrated inertial unit: it moves independently of the ship's motion, which enables it to generate a guaranteed high-quality image."

SeapiX transducer thus generates several multibeam transmissions and acoustic processes to yield quantitative and qualitative measurements of the whole marine environment. Its multiple advanced modulation modes, including chirp, combined with pulse compression guarantee the highest possible detection performance, even in difficult conditions.



▲ Seafloor classification survey with SeapiX

Another major advantage of SeapiX is its ability to provide real-time location-based data by integrating navigational, cartographic, and layers of fishery, bathymetric and sediment information without the need to use a post-processing software.

Unlike conventional sounders – that cover only 7° – SeapiX is able to simultaneously provide seafloor mapping as well as generate a volumetric image of the water column in front of and to the side of the vessel. Nor can they offer a full survey capacity of the entire ecosystem, including both the water column and the seabed classification. With the implementation of this new feature, iXblue truly brings an innovative and efficient solution to its customers, allowing for the study of the interaction between the seabed and the water column. This new global approach will enable scientists and operators alike to get precise and localized real-time data from the entire ecosystem from the seabed morphology to the water surface. "SeapiX particular design offers a unique, safe and reliable operational mode for this new feature enabling real-time seabed classification from either an existing standard library stored into the system, or from a custom-made library created by the customers according to their needs." explains Maxence Rioblanc, Product Manager at iXblue. "SeapiX truly is a reliable system that is easy to use, even for non-specialists, as it does not require complex setting to work, making it accessible to all. This new seabed classification feature will be particularly helpful for various applications such as detection of oil or gas leaks, bottom trawling, risk assessment, MRE monitoring and environmental impact assessment, or even for volcanologists, to only name a few."

Already adopted by major shipowners and institutes worldwide, SeapiX has sparked lots of interest from customers since its launch. Featuring an extremely complex and innovative technology, SeapiX is truly unique as it combines several different capabilities that makes it the perfect solution for a wide array of uses. The new seabed classification feature should be available for customers at the end of the first semester of the year.

SeapiX

3D MBES FOR WATER COLUMN ANALYSIS AND SEABED CLASSIFICATION

Features

- Real-time 3D sonar covering a pyramidal 120° water column with high resolution
- Compatibility with GECDIS systems, Olex (for bathymetry and bottom hardness), Echoview (water column analysis) and Delph Software (classification learning)

Benefits

- Mills Cross dual Multi-beam swaths in a single compact antenna housing with embedded IMU
- Advanced chirp frequency modulation

Performance

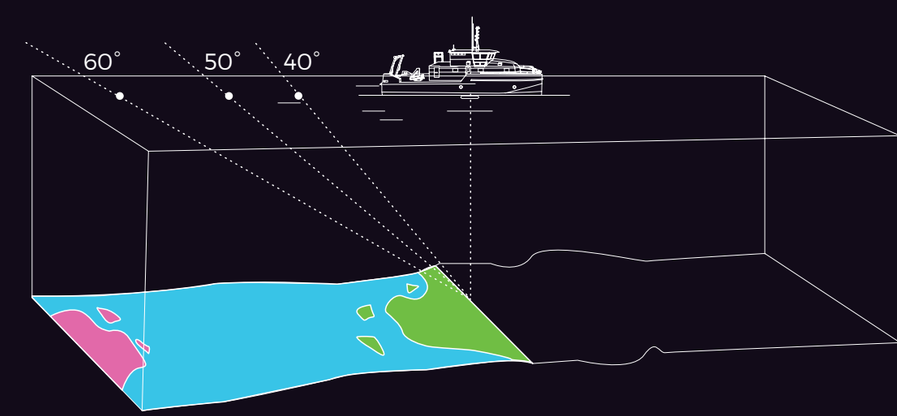
- Range resolution: 7.5 cm (constant)
- Resolution cell at 100 m depth: 0.6 m³
- Typical range: 400 m for fishing. 800 m for bathymetry

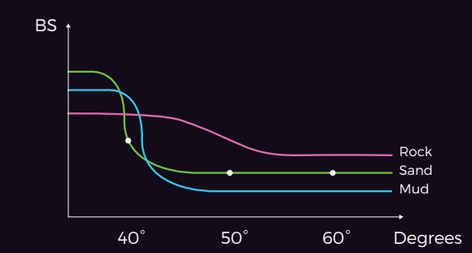
Physical

- Weight: 60 kg (24 kg for portable version)
- Transmission power: 2 kW (4 kW in option)

Applications

- Fishery and fishery research
- Hydrography
- Marine science





NEW TRAINING AND SERVICES OFFER WILL HELP RESHAPE THE FUTURE OF THE OFFSHORE MARKET

2017 saw the birth of a new customer offer within iXblue created to address the many challenges faced by all players in the Offshore market. With this new offer centered around increased training and services, iXblue is seeking to meet its customers' latest requirements and needs for reliable and cost-efficient equipment, easy to deploy and operate. Thanks to this new enhanced training and services business line, iXblue will offer a complete solution, from the design of the products to their setting to works. This new offer will also help the company to further develop an already strong customer care culture through the diversification of its activity on the Oil & Gas, renewable energy and deep sea mining markets.

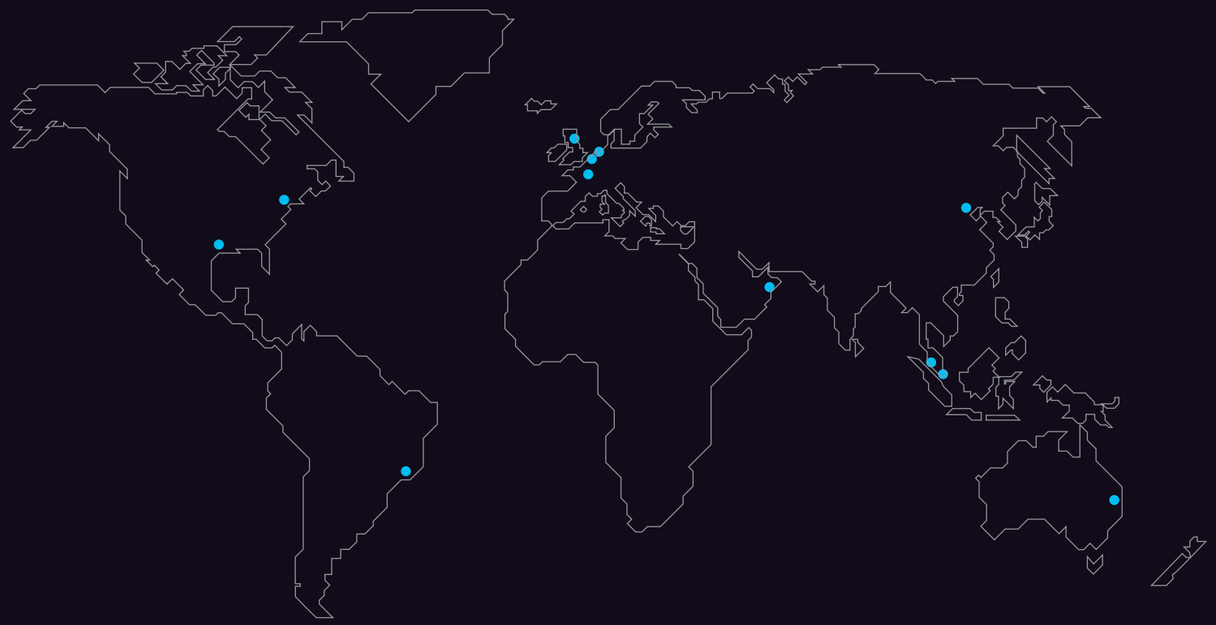
"Our customers must be confident they can find trained operators for our systems and products. In the absence of trained operators, they must be able to get their own and freelance staff trained quickly and efficiently." explains Jim Titcomb, Offshore Technical Manager at iXblue. "This is why we decided to create a new dedicated training facility. Called iXcampus Aberdeen, this new center will feature permanent classroom facilities that will enable us to provide customers with constant training courses. We are also developing a "Services" activity which aim will be to send iXblue Offshore personnel on our customers' operations in order to help them get the best out of our products and systems. This "Service" personnel will thus be here to share their knowledge and help customers with the configuration of the equipment. In some cases, they might even have to operate the equipment for the customers."

In order to bring real innovations and help customers achieve trouble free and efficient operations, the iXblue teams working on the Offshore market decided to promote innovation by developing strong synergies between all employees involved on this market. Thanks to this cross-fertilization, iXblue will thus be able to bring new innovative systems and agility to a market that needs new solutions. From March 2018, Aberdeen has thus become the hub for all Offshore activities within iXblue with the opening of the new iXcampus. This new facility will allow for the set-up of a regular training schedule throughout the year, with dedicated iXblue staff, for enhanced customer support. Thanks to this new world class training facilities, customers will be able to get hands-on training on products developed by iXblue.

"With this new extended offer, our services staff will take the driver's seat in customers' operations." explains Jim Titcomb. "It will boost customers' confidence as they will get a good grasp and understanding of the equipment they bought and that they will be using for their offshore operations".

▼ Abdereen harbour, where is based our team in the UK

Worldwide Footprint



02

CUSTOMER STORIES

FIBER-OPTIC

NAVIGATION EXCELLENCE AT THE HEART OF SAILING'S GREATEST RACE

The challenger, Team New Zealand, won the race over the defender, Team USA

The 2017 America's Cup is the perfect showcase for iXblue technological excellence – with tangible benefits for everyone from raceboat skippers to live TV viewers around the globe.

The drama and excitement of the 2017 America's Cup was beamed live onto screens across the world to be enjoyed by tens of millions of TV viewers. This latest edition has confirmed the transition of the world's oldest continually-contested international sporting challenge from a niche-market elite event into a global media phenomenon. Among the household name partners like Louis Vuitton, BMW and Oracle, viewers may also have noticed the brand of iXblue prominent in their TV pictures. And with good reason, because iXblue's industry-leading inertial measurement and navigation systems are one of the cornerstones of the technological revolution underpinning this event.

Recognized as a global leader in the design and manufacturing of innovative solutions for maritime navigation, positioning as well as imaging and as having revolutionized maritime and naval systems over the last decade, iXblue technology was naturally chosen for the America's Cup, not only by all six competing teams to equip their catamarans, but also by the event organizers as a key component of the race management infrastructure.

Creating an Emmy-award winning sporting event

Match-race sailing has everything a sport needs to capture the imagination of the viewing public. The multi-million dollar catamarans bristle with enough technology to rival F1 cars. They literally fly above the waves, lifted high out of the water on aerodynamic foils, at eyewatering speeds in excess of 50mph. Their crews boast maritime legends and elite athletes in equal measure – all doing battle in exotic and highly telegenic settings.

It should make for a world-class TV broadcast experience. Yet the America's Cup has traditionally struggled to find worldwide universal appeal, mainly because the races themselves have always been notoriously difficult for spectators to follow and understand. Start and finish lines, as well as course markers, are difficult to see. Boats may be travelling in different directions half a mile away from each other one moment, then just meters apart on apparent collision course the next.

Today, all that is changing, thanks to AC Liveline, the company responsible for producing the America's Cup broadcast pictures, and their use of iXblue's Airins inertial navigation system (INS). Airins provides all the data required to produce an immersive new TV viewing experience that takes the spectators right into the thick of the action, using augmented reality technology to help them understand the race as it plays out. Highly detailed graphics overlaid directly onto the live pictures being transmitted from the film helicopters mean viewers can see immediately and in real time the speed of the boats, how far they are from the next marker, the course boundaries or indeed the finish line, and, most importantly, which one is in the lead.

Overlaying graphics on the live video feed requires geo-localization of the film helicopter to within a few centimeters and knowledge of the orientation of the camera to within 1/100th of a degree. Which is where the iXblue's Airins system comes in, fitted to both the official helicopters filming the race. It relays ultra-accurate real-time positioning data which, combined with the GPS data on the location, speed and heading of each raceboat, enables real-time mapping of the relative positions of the craft. This in turn generates those game-changing overlaid graphics and the compelling coverage that keeps viewers on the edge of their seats.

Augmented reality based on real-time data gathering and processing is not new. It has been an integral element of broadcasting of sports such as American football and motor racing for some years. More recently, coverage of soccer, tennis, golf and cycling have all expanded to incorporate a rich, data-driven viewer experience.

America's Cup racing is not like these land-based sports with their pre-defined playing areas. Cameras are mounted on helicopters which follow the race action as closely as possible. Pilots track every split-second decision the skippers and tacticians make in the heat of battle, following each twist and turn as the race unfolds to capture all the critical moments and winning manoeuvers. In such circumstances, the data precision and reliability constraints increase exponentially, pushing into territory where only iXblue's class-leading accuracy and field-proven reliability can deliver.

"It's a harsh environment. We're out in the weather, with the vibration of the helicopter, and the Airins just withstands it all flawlessly."

- Ken Milnes

AC Liveline control room

Airins fitted onto the helicopter camera mounts

iXblue's pedigree of designing systems for use in the most hostile of environments means that Airins is more than robust enough to handle the extreme vibrations from the helicopter as well as the constant battering of the wind, the weather and the saltwater spray with ease. "We turn the Airins on every morning, we run it all day long, and it stays accurate throughout the day," says Ken Milnes, Senior Engineer with AC Liveline. "We've been using this device for five years now, and we've never had any failures."

This reliability combines with the operational flexibility and ease-of-use upon which iXblue has built its reputation. Airins is compact enough to be fitted directly onto helicopter camera mounts. It's simple to configure and operate on the fly, thanks to a highly intuitive user interface. Technicians can define offset parameters smoothly and quickly through a web browser, while ultra-accurate heading, roll and pitch data are delivered in real time through a comprehensive data interface featuring the highest possible update rates. What's more, as Milnes confirms, Airins does all this consistently, without fuss, whatever the operating conditions. "It's a harsh environment. We're out in the weather, with the vibration of the helicopter, and the Airins just withstands it all flawlessly."

Helping the competing teams get the most performance out of their boats.

That signature dependability, flexibility and accuracy also make iXblue's systems the natural choice for extreme high-precision navigation aboard the raceboats themselves.
Built around the same revolutionary fiber-optic gyroscope technology that lies at the heart of the Airins, iXblue's Quadrans gyrocompass and Hydrins inertial navigation systems equip all six boats in the America's Cup fleet. Just like the Airins, these units are solid-state and feature strap-down technology, which makes them perfectly suited for high-performance in the harsh environment of a racing catamaran.

Once in situ, their open architecture guarantees seamless interfacing with all major GPS systems and third-party navigation software packages. And working in tandem with the raceboat's GPS system, they produce real-time heading, pitch and roll data accurate to within 1/100th of a degree. That's a level of precision at least three times higher than that which can be attained with GPS alone.

All six catamarans are equipped with Quadrans and Hydrins systems

Which is just as well, because that's exactly the precision required to keep pace with the speed and sophistication of the full-foiling AC50 catamarans of the 2017 event, as Ian Burns of eventual runners-up Oracle Team USA explains: "In the high-speed catamarans we're racing today, the level of accuracy required has increased ten times compared to previous America's Cups. The iXblue Phins system we use tells us exactly where the boat is, what its orientation is and how it's moving at any moment. Even on a moving platform, with the boat heeling and such, it's breathtaking how accurate these fiber-optic gyroscope units are."

Burns is also quick to praise the reliability of the iXblue systems used by his team and the other boats. "We've capsized with these units on the boat. Sometimes they get completely immersed underwater. They're just incredibly robust and incredibly strong. One of the units we're using today was originally bought in 2003, and fourteen years later, it's still going strong."
iXblue's contribution doesn't stop at optimizing raceboat navigation capabilities. It is also helping teams get the most performance out of their boats. The AC50 catamaran is a brand new class, developed over the last few years specifically for the 2017 America's Cup, and

WE'VE CAPSIZED WITH THESE UNITS ON THE BOAT. SOMETIMES THEY GET COMPLETELY IMMERSED UNDERWATER. THEY'RE JUST INCREDIBLY ROBUST AND INCREDIBLY STRONG."
- IAN BURNS

The defender, Team USA, battling for victory

iXblue's Bragg Gratings are at the core of the catamarans' foils

IXBLUE IS A NATURAL PARTNER FOR THIS EXCITING ERA OF EVOLUTION OF THE FASTEST AND MOST GLAMOUROUS EVENT IN WORLD SAILING.

teams have very little experience racing it. Every outing in race conditions is a new opportunity to gather critical data, to push a little bit further up the learning curve. To the point where the ultimate prize is just as likely to go to the team who can gather and process the best data as it is to go to the one with the best sailors.
"This is as much a design race as a sailing race," says Mauricio Munoz, an engineer with the British Land Rover BAR team, and he's not kidding. The boats are covered with literally thousands of sensors mounted on every key component, all recording every moment of every race. The ability to monitor and analyze that data, not only after each race, but also during the action, is critical. It enables teams to make the marginal adjustments and heat-of-the-moment judgment calls that can be the difference between winning and losing.

No surprise, then, to find iXblue fiber-optic technology at work here too. Go below the waterline on the Groupama Team France catamaran, and you'll find iXblue's all-fiber sensing system fitted to the foils and rudders that are so crucial to the boat's speed. These slivers of carbon fiber (each foil is no bigger than a surfboard) are all that is in contact with the water when the boat is foiling in full cry, so they are obviously subjected to tremendous stresses. Any under-performing foil can massively reduce speed, while overloading can easily lead to a race-ending, and potentially catastrophic, breakage.

So iXblue has developed several arrays of Bragg Gratings which uses fiber-optic technology to monitor the geometry of the foils and rudders, enabling detection and correction of any excessive micro-deformations. Optimizing the efficiency of these critical components contributes to maximum performance, and keeps the crew of the boat safe by permanently anticipating and managing the risk of structural damage.
It's just one more example of iXblue's unique and wide-ranging contribution to the success of the 2017 America's Cup. Gathering, analyzing and distributing data with the utmost accuracy and total reliability in the harshest possible conditions, and getting it right every time.
iXblue is a natural partner for this exciting era of evolution of the fastest and most glamourous event in world sailing. Ian Burns of Team Oracle USA sums it up perfectly: "High-speed data is what we've really become all about with these new high-speed boats. The iXblue units do a great job of that." ■

Triton during a mission off the coast of Marseilles (France).

TRITON

calm in choppy waters

iXblue's loyal customer, the DRASSM, has been operating Triton, its survey vessel, for over a year now. After a number of sea operations, some adjustments, and a very positive experience, Damien Vignes, who was Project Manager within the Shipyard division at iXblue, continues to nurture his gem of technology.

Four years after the delivery of André Malraux, the first vessel ordered from iXblue, the French Department of Underwater and Undersea Archaeological Research (Département des recherches archéologiques subaquatiques et sous-marines (DRASSM)), based in Marseille, took delivery of Triton, its second vessel 'made by iXblue' in December 2016. After a year of exploration, training missions, and fine-tuning, what is Triton up to now? Damien Vignes, Project Manager at iXblue, explains how Triton came about.

"We knew the DRASSM very well, having worked with them on the design of the ship André Malraux. They contacted us again in early 2016 because they wanted a new vessel to replace a small 9-meter craft that had come to the end of its life. DRASSM director Michel L'Hour had described the new vessel in the following way: it was to be no longer than 15 meters to archaeological research on the French Mediterranean coast and, more specifically, to operations within the coastal strip.

For iXblue, this marked the beginning of our 'mission impossible', with L'Hour asking us for all the most up-to-date features possible. We quickly realized that the vessel he dreamed of was more like the André Malraux than a backup boat."

The DRASSM and iXblue have collaborated throughout the development of Triton to fine-tune the specifications requested.

Today, one year after the delivery of Triton in early December 2016, Damien Vignes, proudly describes the work done by his team. "I think we've met the challenge pretty well. So many features in such a small boat! And remember, no feature has been installed at the expense of another. Everything is hyper-sophisticated, unique and fully operational in a length as short as 14.5 meters: the crane, the large deck area, the boom, the inclusion of an office for researchers, the single-arm gantry crane, and so on..."

The vessel

Following the order that was placed by the DRASSM in April 2016, the vessel was launched in October and delivered in December. A record time for the completion of the project. Especially if one takes into account Triton's characteristics and complexity, the boat is pretty much a "one-off". This is the first vessel of this size with so many features built by iXblue. Its hull and its structure are derived from the pilot boats which have been manufactured for a long time by the naval shipyard at La Ciotat. "We used the mold from the pilot boats, which is 12 meters long, but lengthening and widening it a little." says Damien. In the same way, our engineers and designers have used existing tools, while introducing innovations. The rear single-arm gantry crane, for example, represented a real technical challenge: "We quickly realized that the single-arm gantry was the only way for

Lowering a wave recorder into the water from Triton's back deck.

Following the order that was placed by the DRASSM in April 2016, the vessel was launched in October and delivered in December. A record time for the completion of the project.

putting objects into the water. As a result this created obvious structural problems, since it rested on a single support, and not two. We first looked into the possibility of using aluminum - the conventional option - but that wasn't right: it was much too heavy. So we decided on carbon, which is much lighter, and we used a tapered flange I-section structure, usually reserved for the assembly of ships' hulls. It was necessary to optimize the weight and performance. Finally, we came up with a gantry that was solid, light and elegant, which was a real bonus!"

Working with the DRASSM

One team was based in Marseilles, the other in La Ciotat; relations were fluid and easygoing. And though the DRASSM were very clear about what they wanted, the teams at iXblue were also able to make their own contribution to the overall result. "We improved some aspects." explains Damien Vignes. "For example, the front, where the bench seats and galley are located was also to include toilets and showers. We suggested that the showers be located outside. That way, we gained lots of space for the divers, as well as the engineers at the front." But though the vessel is comfortable, it's not meant for pleasure cruises. Since the missions take place during daytime, there are no berths on Triton. Why not? Mainly because of the size and the more restrictive regulations on missions lasting longer than 24 hours.

Among the other suggestions made to the DRASSM by the teams in La Ciotat, there were equipment changes; a platform for divers that would be as practical as possible, in other words as close to the water as possible, which was not easy with a vessel that can remain stationary over long periods but not necessarily in calm waters; and also, and, most importantly, the propulsion, a key point in the design of these vessels.

When the divers are in the water, the ship must remain stationary. However, when a dive is in progress, a propeller system cannot be used to maintain this position as it would be too dangerous for the divers. There are therefore several different types of propulsion.

That is the big difference between André Malraux and Triton. The latter has integrated hydrojets as its main means of propulsion and a new dynamic positioning technique at a price that defies any competition.

Regarding its material, Triton is similar to another ship recently launched at La Ciotat: FeliX. It comprises composite fiberglass and polyester resin, carbon, but also PVC foam, balsa wood, etc. "In each case, you have to find the right trade-offs between price, strength and weight."

Into the water!

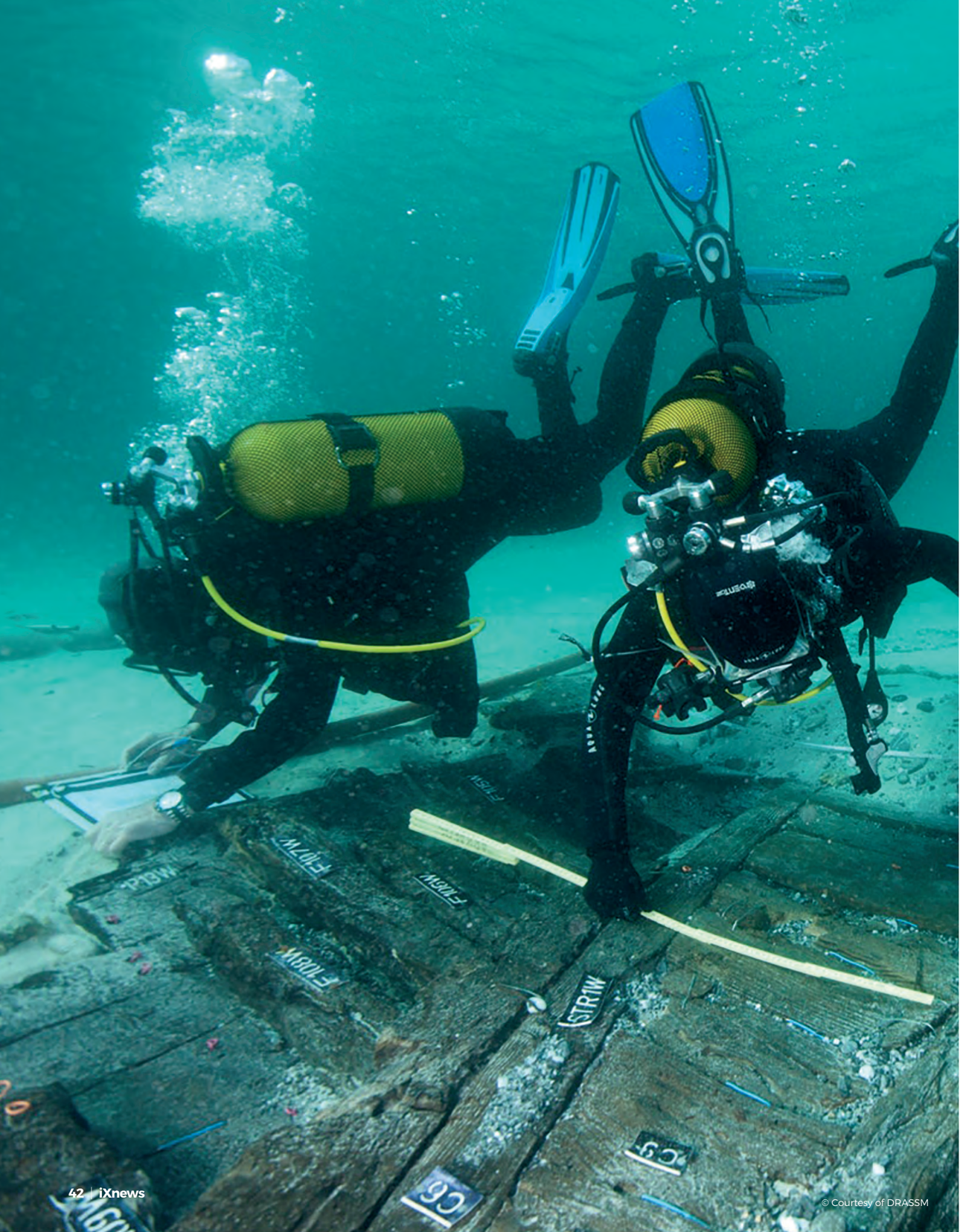
In 2017, Damien Vignes and his teams finally had to let Triton go (what made it even more difficult is that another company, not iXblue, is going to be responsible for the maintenance of the vessel). They do hope to have the opportunity to work again with the staff of the DRASSM, who are well-liked among iXblue. "We really like working with the DRASSM", says Damien Vignes. "It's fun and really interesting. They do so much great work 'free-of-charge', researching our past, our history. And they are part of the Ministry of Culture!"

But having finally let Triton go does not mean the bonds have been broken entirely. Far from it. "The boat is under guarantee... We are here if need be!" And a member of the iXblue Sea Operations division often takes part in missions. iXblue' Shipyard also has reason to celebrate Triton's successes on certain missions carried out in difficult conditions, such as the week-long trial mission, when the Hilarion robotic ROV was launched in rough waters (sea state 3) and a strong breeze (with a wind speed of 20 to 25 knots). It weighed 200 kilos plus 600 kilos of winch on the deck: "It was quite daunting", explains Damien. In the end, it all went very smoothly. ■

Prepping a side scan sonar on Triton's back deck.

«We really like working with the DRASSM. It's fun and really interesting. They do so much great work 'free-of-charge', researching our past, our history. »

- Damien Vignes



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Interview with Michel L'Hour, Director of the DRASSM

Michel L'Hour, the director of the DRASSM, has roamed the depths of the ocean, and continues to explore it for the greater good of research. It is with him that iXblue has worked to design Triton. He accepted to share the story behind this exceptional collaboration.

It is from Marseille that he took time out, between two missions, to tell us about the close collaboration that has linked iXblue and the DRASSM over the past few years. The first order to the Shipyard division was for the vessel André-Malraux (delivered in 2012), while the second was for Triton, which joined the ranks of the DRASSM in December 2016 and has already conducted a number of sea operations.

"At the moment [July 2017], it is in the Rhône delta, on an archaeological mission. We are very pleased, as it has proven to be fully complementary to the André-Malraux. Indeed, the aim was for it to provide an alternative to the Malraux that already has a heavy schedule for the next few years, working between the Channel, the Atlantic and the North Sea. Triton will be particularly useful for archaeological impact assessments being carried out prior to wind farm construction – an activity that also concerns the DRASSM. The lower tonnage of Triton is perfect for the one-day missions it is dedicated to in the Mediterranean and in coastal areas."

André Malraux, a 36-meter long workboat delivered to the DRASSM in 2012

© Courtesy of DRASSM

Triton can carry a crew of around 10 people, explores wrecks a few nautical miles offshore and returns everyone to land in the evening. The fact that mainland France alone has 5,500 km of coast and that there are between 3,000 and 7,000 wrecks in the Mediterranean, gives a good idea of Triton's busy schedule.

Many ships are lying at a depth of tens or hundreds of meters off the coast of Marseille, Toulon or Corsica. However, they cannot be reached by humans, as divers with oxygen tanks are limited to a depth of 40 meters. This is why Michel L'Hour has set up a major research hub, in collaboration with Stanford University in the United States and LIRMM, the Laboratoire informatique de robotique et de micro-électronique de Montpellier (Montpellier Laboratory of Informatics, Robotics and Microelectronics. The aim of this hub being for humanoid robots, embarked on Triton, to explore the depths of the sea.

With an almost human appearance, using cameras instead of eyes, and three-fingered "hands" (allowing it to gently pick up objects to examine or take back to the vessel), the first of these robots was named OceanOne. In 2016 it completed its inaugural dive to La Lune, a ship belonging to Louis XIV that sank off the coast of Toulon in the 17th century.

Hence, the importance of the single-arm gantry crane developed for Triton by the teams in La Ciotat and which is used to lower the robots in and out of the water. "It's true," admits Michel L'Hour, "the specifications were complex. We requested this single-arm gantry crane, which no one knew how to make at first." During Triton's christening ceremony, Sébastien Grall, the director of iXblue' Shipyard, even added: "In the end, we like the demands made by the DRASSM, as it pushes us to invent new things!" He is certainly not wrong. We're not talking about a Christmas list for Santa, but it's not too far off. Let's say we are not shy about listing virtually everything we want."

And even once the project is finished, "virtually everything" is still not enough. During the breaking-in period of Triton in 2017, the DRASSM identified a few small changes to be made to the boat. "It wasn't Triton's fault," explains Michel L'Hour, "but we wanted to make it even better. For example, we are going to try to install the suction system, the wet vacuums, in the engine room rather than on the bridge, to make it less noisy for the divers and other people working there. Having spent my whole life diving and working in noisy conditions, which has made me half-deaf, I think it's important for my colleagues to have better hearing than me when they get to my age!"

In 2018, Michel L'Hour wants to send Triton to Corsica. "There are some very deep wrecks between Corsica and Italy (at depths of 300 to 700 meters), and many more along the coast. It would be a perfect place for Triton to put its talents to use. With its low tonnage, it could return each evening to ports that the Malraux wouldn't be able to enter. It would also be an opportunity to explore deep-sea archaeology even further, on very deep wrecks. We have already exceeded our ambitions, achieving in five years what we had hoped to achieve in 10 or 15. Our objective, before 2020, is to be able to perform digs at up to 600 meters using machines, while meeting the same level of requirements and achieving the same results as humans at a depth of 20 meters." With a vessel like Triton, nothing seems impossible for the DRASSM and its divers, both human and humanoid. ■

Triton can carry a crew of around 10 people, explores wrecks a few nautical miles offshore and returns everyone to land in the evening.

Launching a mini-ROV equiped with a camera from André Malraux during a mission in the Mediterranean

BIBBY HYDROMAP ONBOARD!

2017 saw the birth of DriX, iXblue's autonomous unmanned surface vessel (AUSV), to fill in the gap of not entirely satisfactory solutions on the market, and to fulfil the company's needs for an offshore-going unmanned solution to win an important survey contract in the southern hemisphere.

As the saying goes, "to plan early is to plan twice". The initial plan was to limit the number of AUSVs in production to the amount iXblue would need to work on that contract. However, once the contract was won, and DriX started its sea trials, the teams at iXblue reconsidered. They were properly amazed by the second-to-none seaworthiness of the 8-metre long surface drone, and by the relevancy of Sebastien Grall's (VP Shipyard Division) initial design options regarding the creation of a purely hydrodynamic and energy saving asset, fully dedicated to good quality data gathering. DriX was indeed exceeding the initial needs and certainly triggered the interest of all who heard about it. It was therefore decided to go to the market with the product.

However, from a purely Business Development point of view, iXblue was faced with the difficult issue of advertising a new and, in a way, revolutionary product, with few legislation attached to it, and no facts to back the company's story apart from iXblue's own testimony. It was thus necessary to find a well-known and capable development partner, technology-ready, who would work with DriX on one of the targeted markets and who could guide iXblue through further needed technical developments. Another thing the group was looking for was a herald. All those qualities were found in Bibby HydroMap, with whom an "early adopter contract" was signed and which will hopefully turn into a customer one in the future. All things considered, this venture is not surprising at all. Bibby HydroMap and iXblue share a number of similarities. Both companies are reasonably young, performance and quality driven, and keen on using the best technologies the industry can offer.

On the iXblue side, this contract is already showing a number of strong positive aspects, one of them being to clarify things with insurance brokers and to take part in implementing Surface Drones within the French and International (IMO) legal frame. On that front, the Industry has to take its responsibilities and contribute to shaping the future. That part was highlighted when iXblue first started to work on its collaboration with Bibby HydroMap, exploiting DriX. Identifying the safeguard within a non-existent frame is not an easy thing. It is also certainly most interesting to have partners thinking outside the "blue bubble" and speaking out for the iXblue brand. ■

BIBBY HYDROMAP

Here at Bibby HydroMap, we are always looking for the leading technology to help us offer excellent customer service. Since 2011, we have been working closely with iXblue, mobilising multiple iXblue navigation systems to each of our offshore survey vessels for survey positioning, motion and DP control. The performance and build-quality of these systems has been outstanding, and the customer service we have received has shown us that iXblue are very much aligned with our customer-driven ideals.

When the opportunity came up to get involved in the DriX project, it was clear that this development could revolutionise the world of hydrographic survey, and was already a step ahead of existing autonomous market offerings. Knowing that the DriX was being developed in La Ciotat in tandem with the existing product lines gave us confidence that it would be a first-class product, and as discussions moved forward, the enthusiasm shown by iXblue was infectious.
We fully expect DriX to be in high demand within our existing client base, allowing us to offer not only increased data production, but reductions in cost, which are critical in our desire to increase value to customers. The high data quality observed during the sea trials has shown us that DriX can be a true extension of our survey vessel, and as the unit is developed further, we are very excited to explore the limits of its capabilities and bring it to market in the UK and Northern Europe.

- Michael King,
Business Development Manager

A TELESCOPE TO LISTEN TO THE UNIVERSE

© Courtesy of KM3NeT

How the submarine telescope works. ▶

iXblue recently took part in the deployment of a major submerged telescope off the coast of Toulon, the purpose of which is to observe particles from space which are quasi-undetectable in terrestrial environments. We take a closer look at this unusual project, which proves that underwater acoustics can achieve pretty much anything...

The European project KM3NeT (Kilometer Cube Neutrino Telescope), in which iXblue has been involved for many years through the pilot project ANTARES, is one of those missions which allows acoustic positioning to flirt with research in fundamental physics. Bringing together a whole host of institutes of physics, astronomy and oceanography from all over Europe, this project aims to deploy networks of sensors on several sites in the Mediterranean off the coasts of France, Italy and Greece. Precisely distributed according to predefined schemas, these networks of photosensitive underwater sensors in reality come together to form telescopes that make it possible to observe particles in space which are quasi-undetectable in terrestrial environments: namely, neutrinos.

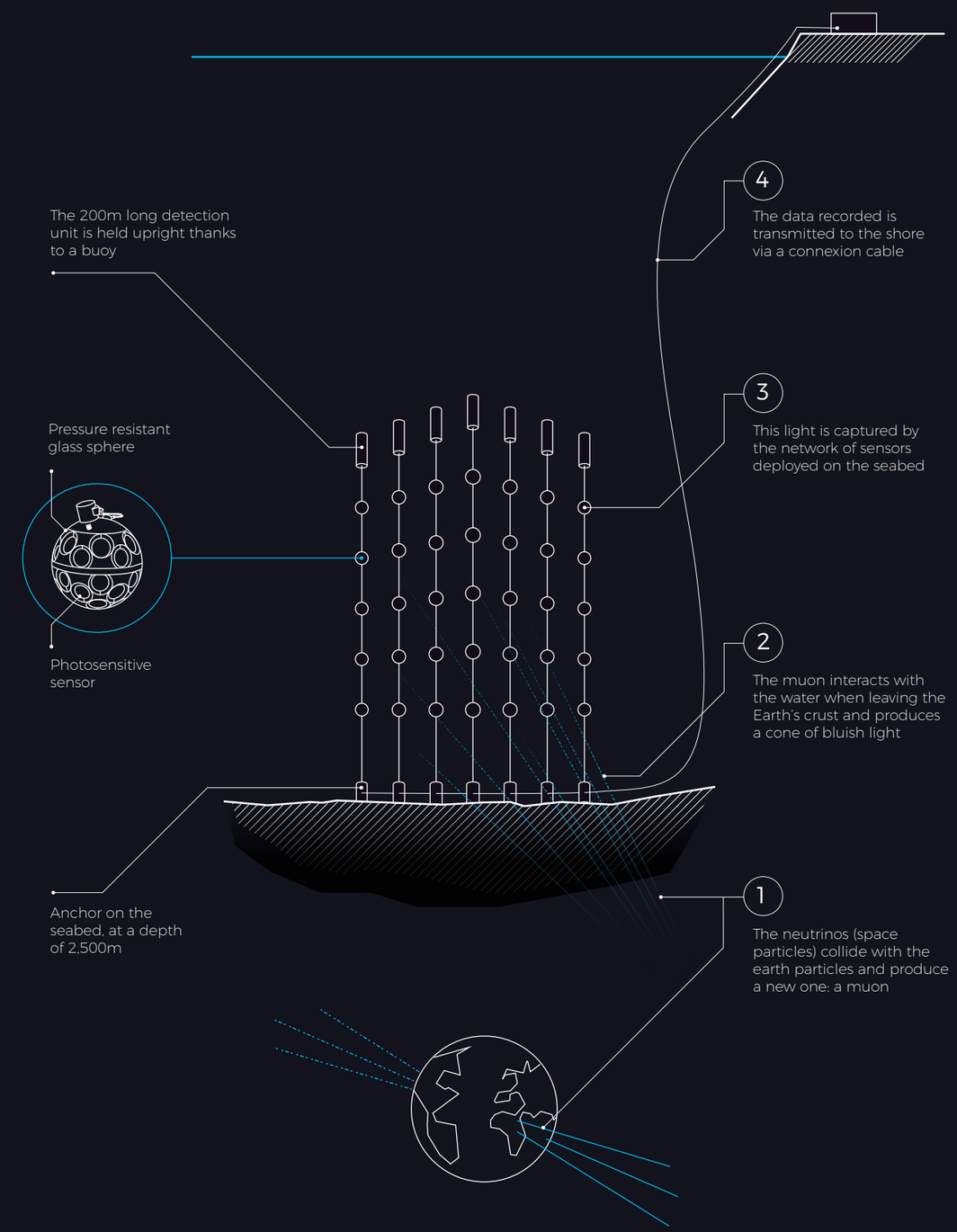
Discovered in the middle of the 20th century, these elementary particles are at the heart of the research being conducted within the framework of some of the largest experiments in fundamental physics on Earth. While the heavens have always been observed with the help of photons emitted by celestial bodies, the intrinsic properties of neutrinos make them excellent indicators of the most distant events in the cosmos. After all, the neutrino is stable and neutral, meaning there is no risk of it disintegrating during its journey or being deviated by magnetic fields. It is therefore possible to approximately locate the direction of its source; moreover, its low interaction cross-section means it is able to pass through dense zones of the Universe, such as at the edge of black holes or cataclysmic phenomena; lastly, it carries information about the nuclear phenomena at its source. These exceptional properties will ultimately also make it possible to observe the skies more efficiently, but also to locate more precisely the sources in space.

The counterpart to this relatively furtive nature of the neutrino is that it is difficult to detect...How is it possible to precisely observe a particle which interacts so little with its environment? The answer to this question is: you "simply" use the Earth as a target!

Indeed, when a neutrino passes through the Earth, there is a chance, though only a slight one, that it will interact and collide with the particles of which it is made up. When such a collision occurs, another elementary particle – a muon – is generated, following a trajectory based on that of the neutrino. However, upon the change of environment caused when it exits the Earth's crust, this muon has the specific feature of interacting with water and generating a cone of bluish light known as Cherenkov light, the equivalent of the supersonic bang for light! Captured by a telescope made up of a network of photo-multiplier tubes positioned precisely underwater to avoid any external light pollution, this light thus makes it possible, thanks to the analysis of the angles of the cone of light by the network of sensors, to precisely reconstruct the course of the particle and therefore to precisely locate the source of the neutrino.

The neutrino, as a furtive indicator of some of the least observable cosmic phenomena of our times, thus becomes detectable thanks to the placing of networks of Cherenkov light sensors in the depths of the sea... But how exactly are these complex networks of photo-multiplier tubes to be deployed? It was to this end that iXblue was contacted in 2014 by the Marseille Particle Physics Center (Centre de Physique des Particules de Marseille – CPPM), which is responsible for the deployment of the KM3NeT-Fr facility in French territorial waters, on a site off the coast of Toulon, at a depth of 2,500 meters.

Implementing this telescope, consisting of tens of lines themselves made up of 18 optical module cells, requires a high degree of precision at every step in its deployment. Imagine having to deploy a structure weighing nearly three tons into a 1 meter target...from a crane that is as high as 8 Eiffel Towers! A strictly impossible operation without high quality positioning. While this type of operation is performed on land using GPS or laser positioning, water, by its very nature, does not allow for the use of such technologies. Unlike acoustic waves, electromagnetic waves and light propagate extremely poorly in this environment. Designed and developed on its Brest site, iXblue's range of positioning products is built on several decades of experience in the design of acoustic releases and beacons, and has more recently been expanded to include top-of-the-range positioning equipment such as the Posidonia and Ramses systems. In the call for tenders launched by the CPPM in 2014, it was Ramses, iXblue's LBL (or "long baseline") positioning system that was selected for the monitoring of devices and the location of the underwater structures.



Implementing this telescope, consisting of tens of lines, requires a high degree of precision at every step in its deployment.

iXblue was duly called upon by the CPPM in September 2017 for deploying and calibrating of the reference beacons. Carried out in good weather conditions from iXblue GGIX catamaran, this phase went off without a hitch, thanks to the presence of a support team from iXblue on board.
Unusually, for this project, Ramses was installed on the vessel and not on the device to be positioned, though the principle of positioning still remains similar, with vehicles and structures being located using distances to the reference beacons. Ramses was thus coupled to a Hydrins inertial navigation system, which was itself connected to a GPS, so that its position could be known precisely at any moment.

During the course of this mission, the calibration of the reference beacons was performed by Ramses which made a circle on the surface of several hundred meters around each of the beacons to be positioned. While performing this operation, Ramses constantly measured the distance to this beacon, and integrated it into its Kalman filter to determine its exact position in real time. Thanks to the outstanding autonomy of the beacons, with their position now known, these can subsequently be used to position vehicles in the field for several years, without any further intervention being required.

A second mission was then organized ten days later for the installation of the first line of Cherenkov detectors and its associated infrastructure. During this mission, navigation for vehicles within the field was provided thanks to a beacon mounted on the vehicle which responded to queries from Ramses, whilst re-querying all the surrounding reference beacons. The indirect distances measured in this way ultimately enabled Ramses to triangulate the position of the device in the working area. The installation of the tens of lines which go together to make up the submarine telescope was carried out using beacons from iXblue's Oceano range, which not only enable the lines to be positioned by Ramses during deployment, but which are also used in their handling, from lifting to their release down to a depth of 2,500 meters. All this being possible despite the considerable weight of the line deployment modules (weighing nearly 3 tons). This time, the support team from iXblue and members of the CPPM used vessels from COMEX and Foselev Marine for the mission, which were equipped with ROVs (Remotely Operated Vehicles) and Dynamic positioning (DP) systems enabling them to maintain a perfectly stable position during operations... At least in theory: in fact, in contrast to the calibration phase, only one single structure was able to be deployed this time due to extreme weather conditions, with 30-knot winds pushing the DP system to its limits, and the vessel having trouble to hold its position...but managing to do so all the same.

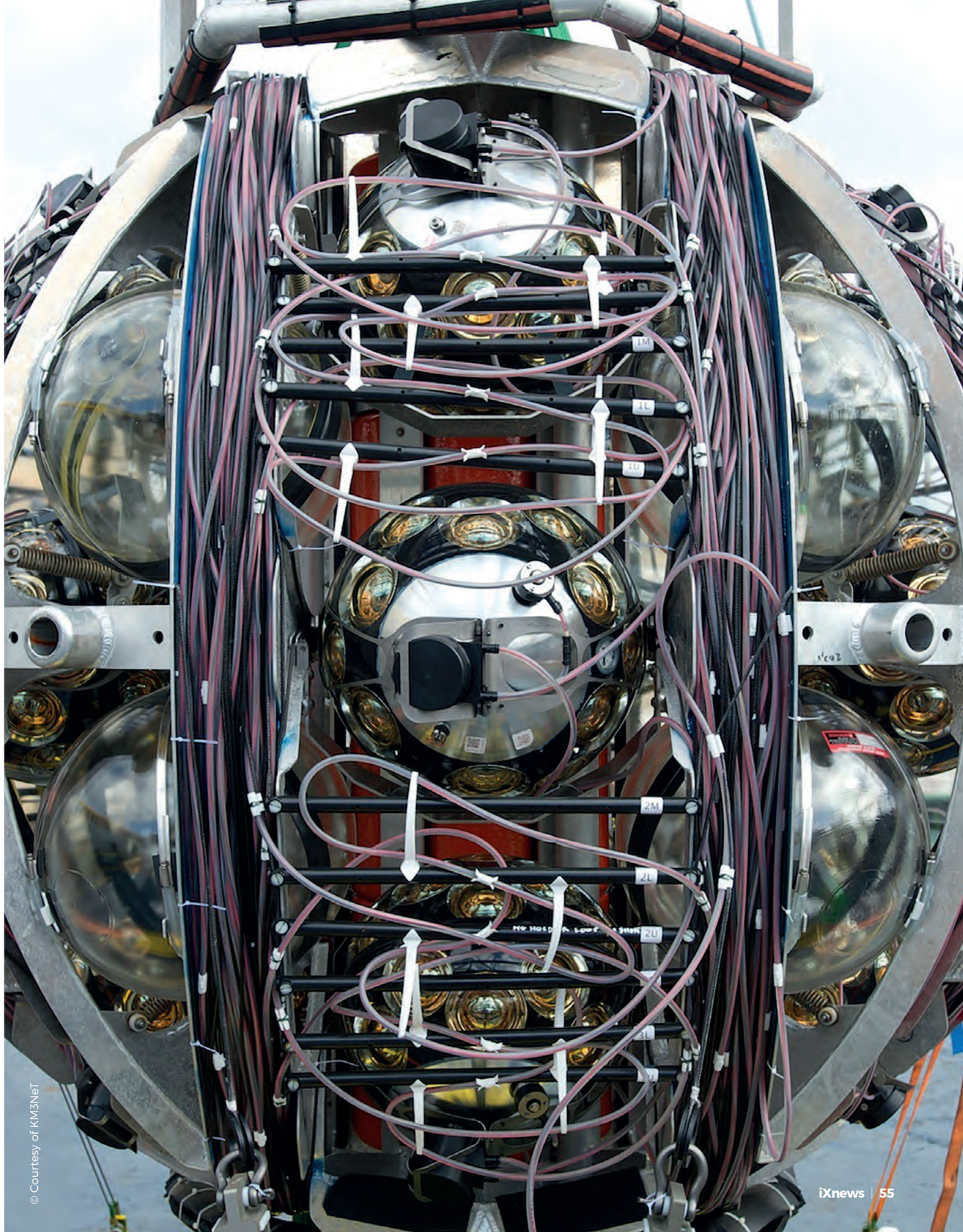
Despite these difficult operational conditions, Ramses managed to provide excellent positioning, but the driving wind obliged the Manager of Operations to postpone the lowering into the water of the first line and of the CNRS's oceanographic acquisition module. A third mission was organized several days later, in the first window of favorable weather. The two vessels, JANUS and CASTOR, then worked for several days (and nights!) at a distance of just a few meters from each other with equipment connected below the surface, a deep casting winch deployed and a ROV operating at the same time at a depth of 2,500 meters below the surface. A painstaking operation which put all the know-how of the respective captains and crews to the test.

Under such conditions, positioning the equipment on the sea bed is of crucial importance. Ramses thus provided invaluable assistance by enabling the line of detectors to be deployed into its exact position within a "target box" of just 3 meters radius in size. Evaluated based on data recorded during the mission, then reprocessed after operations were complete, the accuracy of positioning of the line during the deployment was brought to within barely 10 to 30cm.

The critical moment of the release and then connection of the first line then followed. All the teams from the CPPM and the CNRS gathered around to watch the video streams transmitted from the ROV. COMEX took responsibility for carrying out these delicate steps.
First, the release: all the sensors are rolled out on the sea bed and positioned on the line. This is a magical moment. The neutrino detectors, which are tightly wound around a round structure, deploy themselves before the very eyes of the team present. The ROV lowers its headlamps so as not to damage the ultra-sensitive sensors and moves back up the line. Everyone counts the sensors, they are all in position.
Then comes the connection: it took several attempts and all COMEX's experience to position the connector at a depth of 2,500 meters. Finally, the teams from the CNRS and the CPPM establish contact with the station on land to coordinate the powering up of the line, and the sensors are ready to record their first neutrinos.

So, on Friday September 22, 2017 at 10:20 pm local time, after the deployment operations were complete and just 20 minutes after the first optical sensors were connected, the system was already detecting its first rays of cosmic muons... The heavens had been heard from the depths of the abyss: a whole host of know-how deployed to listen to the universe! ■

View of the optical module inside the launching vehicle.



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RAMSES: HIGH PRECISION OPERATION IN THE BLACK SEA

In late September 2017 MMT, specialised in marine surveys, and Reach Subsea, provider of ROV services, contacted iXblue to investigate the possible use of Ramses sparse array LBL system on a pipelay corridor in the Black Sea.

Both companies needed to ensure that a 430km pipeline route was clear of unexploded munitions (UXO) or Objects of Cultural Heritage (CHO - wrecks and old man-made objects). Operating with two ROV's at a depth of 2000m, MMT and Reach Subsea needed to precisely follow a series of four survey lines each spaced 7.5m apart. With one of the ROVs fitted with 12 magnetic gradiometers on a 10m wide boom the 7.5m line spacing left little margin for error. The other ROV, fitted with cameras and lasers (for measurements) as well as with a hydraulic dredging attachment, was meant to be used if buried targets were encountered.

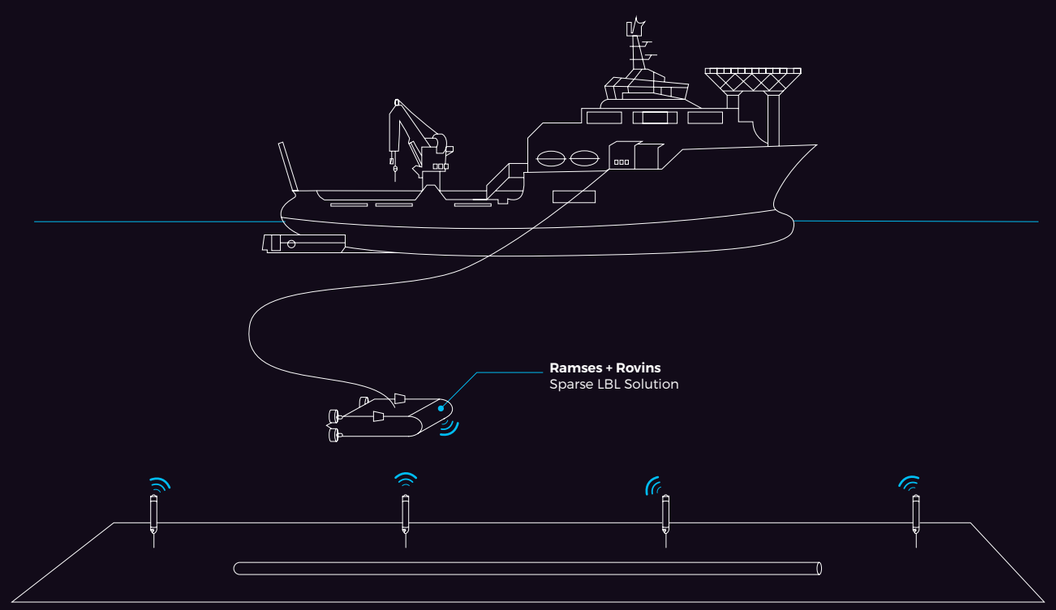
MMT and Reach Subsea were conducting operations using iXblue's Rovins INS DVL aided with USBL data, an approach usually conducted with ease at this depth of water. However, unusual environmental conditions made the operation difficult by rendering the sound velocity profile inconsistent with a very strong thermocline (34m/a change over 2m water depth). The thermocline appeared in the upper layers (top 50m) but moved significantly between sound velocity profile measurements, varying between 20 and 50 meters. The depth of the thermocline seemed to change rapidly, possibly due to internal wave action. This significant change in velocity at such a relative shallow depth lead to varying ray bending and consequently unrepeatable USBL positioning.

In order to solve this issue, MMT and Reach Subsea decided to use Ramses for sparse array positioning meaning that the critical acoustic paths would be close to the seabed and therefore not affected by the varying thermocline.

An analysis of the sound velocity profile close to the seabed, combined with the expected ROV operating altitude and that of the preferred deployment of the beacons indicated that a maximum range of around 1600m should be achievable. The use of tripods or moorings for the beacons was then discussed at length, Moorings are usually avoided for high precision positioning as they tend to move with the tide or current, however MMT and Reach Subsea were happy that moorings would be fine as their investigations into the environmental conditions causing problems for the USBL had indicated there was very little variation in the environmental conditions at the seabed.

Some work had previously been done analyzing the best layout for surveying a pipe route with very sparse beacons. It seemed at first glance, that laying the beacons close to the route would be the best option, while using a large offset from the route would lead to better across route precision. However, a compromise had to be found. The further away from the route the beacons would be, the better the across route performance. But moving the beacons away from the route meant less coverage as a smaller area of the route would be within range of those particular beacons.

© Courtesy of MMT.



The previous analysis had shown that in theory, the required precision of the position could be achieved with only a single beacon in range. Knowing that a maximum of 1800m could be achieved with Ramses, iXblue recommended that each 20km section should be covered by 11 transponders, each offset from the pipe route by 300m. With this solution, at least one beacon would be in range during all of the survey, including significant areas where two beacons would be available.

This mission being an ongoing operation, there was no opportunity to train the customer's staff. MMT and Reach Subsea thus requested that an iXblue support engineer joined the vessel to perform the mobilization and initial onboard training. The support engineer thus assisted with the integration of Ramses sparse array LBL onto the ROV, configuring the Rovins INS to work properly with Ramses and advising on the methodology for the calibration of the beacons.

The initial plan for this mission was to equip the survey ROV with one of the two Ramses systems provided by iXblue while keeping the other system as a spare. However, the vessel being equipped with two ROVS, both Ramses were used on each of them, the inspection ROV being used to deploy and calibrate the third party beacons, while the first ROV was used for the UXO survey operations.

iXblue's support engineer was thus able to install the Ramses on each vehicle. A series of tests then showed that the range being achieved on the survey vehicle was shorter than what had been initially anticipated and that the range achieved by the other ROV was more in line with expectations. Further analysis showed that Ramses was experiencing higher than anticipated environmental noise on the survey vehicle. In order to solve this issue, iXblue's engineer decided to take a number of steps to reduce the noise and improve the range performance. Ramses transducer was thus mounted on top of the ROV to optimize the line of sight in every direction, a plastic mounting bracket was then installed between the transducer and the ROV frame for mechanical isolation, and finally, all cables were routed as far as possible from any of the ROV high voltage/power cables.

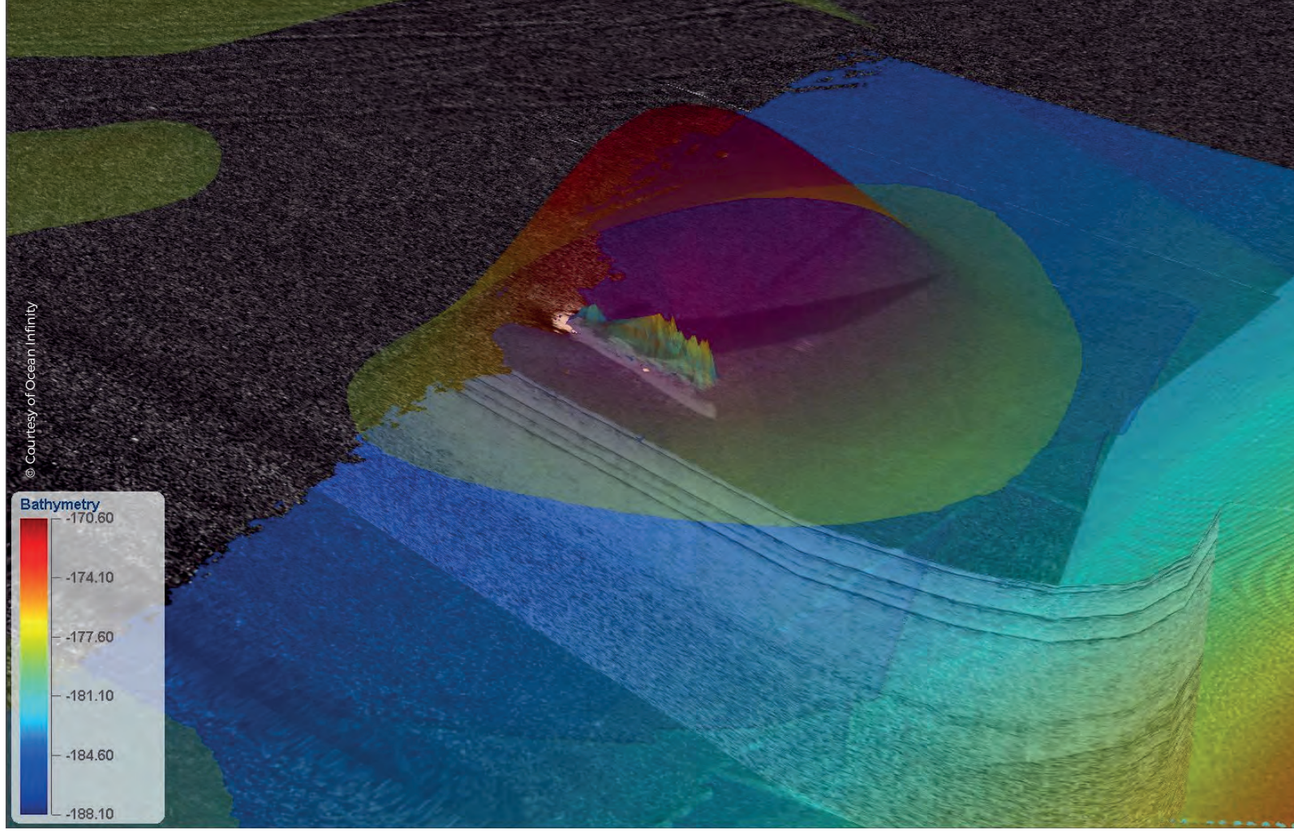
With those changes, the maximum range achieved by the survey ROV was able to reach 1715m, 115m more than theoretically possible on a flat seabed. This excess range was more than likely due to slightly different environmental conditions and a none-flat seabed. Overall, the average range achieved during the mission reached 1330m, a reasonable range when compared to the maximum theoretical range of 1600m.

For this operation MMT and Reach Subsea only used the original USBL system when calibrating the beacon positions. This was done using the SLAM algorithm in Ramses. By aiding the INS with the USBL system and circling the beacon while Ramses measured the range to this beacon, the SLAM algorithm was able to calculate the position of the beacon. The SLAM algorithm is a great solution for correcting some of the typical errors encountered with a USBL system, it is an excellent process to eliminate random noise from the position calculation, but is unable to get rid of systematic errors. By ensuring the USBL system is fitted with a recent velocity profile for each beacon calibration and minimizing the horizontal offset between the ship and the ROV, the USBL problems can be minimized for the short time required to calibrate the beacons.

During the survey of the first line of each section, marker buoys were deployed to allow a quality check on the relative positioning provided by Ramses. MMT and Reach Subsea were thus able to conclude from analyzing targets on overlapping lines that Ramses sparse array LBL was able to provide relative position accuracies on the decimeter level rather than the 15m error budget for the USBL system.

DELPH SOFTWARE: ON THE HUNT FOR MISSING FLIGHT MH370

Surveying the Oceans in the 21st century must be something new. Ultra-deep-water exploration, emerging countries in the need for cost effective means to map their economical areas and subsea resources. In more shallow water as well, the space allocated to the development of renewable energies at sea requires major mapping capabilities that were only available in the Oil & Gas market a decade ago. Humanity is now aware that its future lies at sea.



In this view, iXblue Sonar division developed Delph software suite that focusses on the acquisition and processing of geophysical data. From the tight integration of sensors to cartographic deliverables, Delph handles the transformation from raw side-scan sonar, seismic and magnetometer data to mapping products in a very logical and ultra-efficient workflow. Soon adopted by major Oil & Gas contractors to boost their deliveries, a strong effort was made on the automation of every single task in order to better rely on computer power to work, thus maximizing the time available for geophysicist to work on their added value in data quality control and interpretation. Because no single sensor provides all the necessary information, quickly combining all survey data into a single 3D cartographic environment reduces the risk for errors and ensures a better understanding of the complete dataset.

Delph software performance and optimized workflow has been a great improvement in various sectors where seabed data is a routine production line or when smaller size survey companies need to cope with the amount of data created in marine renewable energies surveys for windfarm development.

In October 2016, Norway based subsea operations specialist Swire Seabed AS came to iXblue to evaluate the performance of its Delph software in processing. Swire Seabed AS was indeed contracted by Ocean Infinity to process the huge data amounts produced by their fleet of 8 AUVs that simultaneously map the seabed. Delph was already in use for various single-AUV projects where geophysicists are under pressure to cope with the data from every dive before the next ones come on the deck. Swire Seabed AS challenge was to multiply the survey efficiency by operating multiple AUV while keeping a limited geophysical processing team on a single main vessel. After successful benchmarking and trials, Delph is now the processing solution onboard the Seabed Constructor vessel for dealing with the side-scan sonar, sub-bottom profiler and magnetometer data. While each AUV acquires data for more than 48 hours, there is much less time between the launch and recoveries on the vessel. All data must be processed in less than 4 hours with minimal human actions, leaving another 10 hours for geos to QC and interpret each AUV dataset. Automating the processing and data production tasks allows Swire Seabed to deliver fresh AUV data in less than 24 hours to their customers with an unpreceded coverage rate.

Since January 2018, Ocean Infinity and its partner Swire Seabed have been contracted to operate this multi-AUV solution in the Pacific Ocean to take over the search of the missing flight MH370 that suddenly disappeared in March 2014. Not only is the Pacific the largest and least mapped ocean, but depths in such a wide area are high and extremely varying. A first search area of 60 000 km² was established and the search effort, still using conventional technology, lasted for 3 years with no hit. Ocean Infinity and its partner Swire Seabed now operate the Seabed Constructor and its fleet of 8 deep-water AUVs and as many USVs for their positioning. Each AUV acquires side-scan sonar data, sub-bottom profiler and magnetometer data that are processed by iXblue Delph software, and multi-beam bathymetry that is handled by EIVA software. The produced maps and interpretation are further integrated in an ESRI ArcGis server that streams the cartographic results to the end client in short time. Operating multiple autonomous vehicles has a multiplier effect that brings the complete survey solution to a whole new level. In terms of vessel architecture, a vast workplace is devoted to the multi AUV maintenance, launch & recovery, a carrousel for deploying all USVs. The IT infrastructure must cope with the Terabytes of data generated and powerful terminals for the geophysicists to process and interpret full datasets. This being all optimized in the view of limiting the crew and rely as much as possible on surveying and processing automation that is now available. In less than a first survey week, Ocean Infinity reported that 4,500 km² out of the 25,000 km² of the primary search had already been surveyed and delivered. The Seabed Constructor now progresses to cover the remaining thousands of km² at a great speed, providing high resolution data collected from the deep.

Jan Arvid Ingulfsen, Senior Advisor Survey & AUV Operations at Swire Seabed AS says: "Ocean Infinity's focus of efficient autonomous operations is a game changer in the seabed mapping area. The efficiency of using multiple AUV's challenges the whole market to be more cost efficient in all aspects of the survey industry. When acquiring data up to 8 times faster than our competitors it is of vital importance we have software that are extremely efficient in handling all these data."

As the world moves on to Artificial Intelligence and automation of all time-consuming tasks, iXblue keeps on bringing innovative and powerful solutions that combine integrated survey platforms, sensors, and software that are market and user-oriented. The company brings cost-effective up-scaling capabilities to survey companies and meet with the 21st century challenge of mapping the entire underwater world.