



KONGSBERG

BRINGING CLARITY TO THE WORLD BELOW

.....
THE COMPLETE UNDERWATER MAPPING PRODUCT RANGE

MAXIMIZING PERFORMANCE BY PROVIDING THE FULL PICTURE

OUR MISSION

We shall earn the respect and recognition for our dedication to provide innovative and reliable marine electronics that ensure optimal operation at sea. By utilising and integrating our technology, experience and competencies in positioning, hydroacoustics, communication, control, navigation, simulation and automation, we aim to give our customers The Full Picture. The Full Picture yields professional solutions and global services that make a difference enabling you to stay ahead of the competition.

OUR PHILOSOPHY

Our success depends on the success of our customers. Actively listening to our customers and truly understanding their needs, and then translating these needs into successful products and solutions is central to achieving our goal.

Our people are the key to our success and we empower them to achieve. Working together in a global network of knowledge, guided by our values, engenders innovation and world class performance. Every day we have to think a little differently, because every client is unique. We aspire to translate the imagination and dedication of our staff into successful technologies and solutions. Our commitment is to add value to your operations by providing you with The Full Picture.

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BRINGING CLARITY TO THE WORLD BELOW

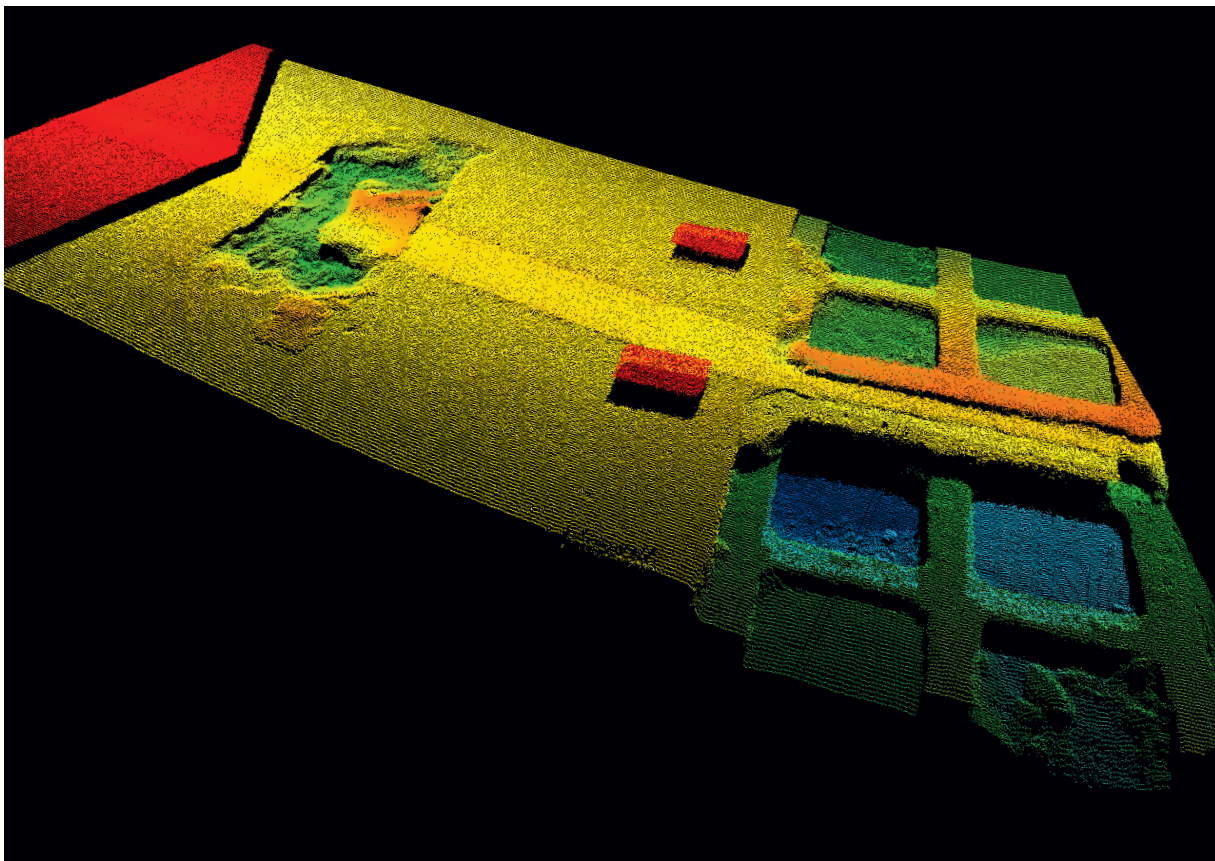
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The technology within underwater mapping is continuously advancing and providing higher quality data than ever before. This technology is taking subsea construction, naval surveillance and the exploration and mapping of the sea floor to new levels, allowing efficient and accurate data capture from waters in sheltered ports to the harshest and most challenging environments.

Kongsberg Maritime is at the forefront of these advancements; there are many challenges to be overcome in the subsea environment and KONGSBERG has spent over 60 years mastering the technology needed to lead the way within the maritime industry.

KONGSBERG offers a broad range of echo sounders that can be operated from any platform, making them ideal for exploring anywhere from the shallowest waters in ports and harbours to the world's deepest oceans.

*Inspecting damage to the floor. Tilbury Docks, London
KONGSBERG product: EM® 2040*



MULTIBEAM ECHO SOUNDERS

Kongsberg Maritime is the leading manufacturer of multibeam echosounders for shallow, medium and deep water applications and has delivered systems since the mid 1980's. Many of the systems have become the industry standard due to their unique features.

KONGSBERG has developed its echo sounders to suit any platform; from large surface vessels to any vessel of opportunity, Autonomous Underwater Vehicles (AUVs), Remotely Operated Vehicles (ROVs), Remote Surface Vehicles (RSVs) and Autonomous Surface Vehicles (ASVs). All EM® multibeam systems have a set of unique features which are vital to meet the requirements conditions set by the IHO S-44, the more demanding LINZ and other specifications set by the survey industry. These requirements are met in any weather conditions.

Sector transmission and real-time stabilisation

In order to maximise the range capability and to suppress interference from multiples of strong bottom echoes, the

transmit fan is divided into several sectors. Each sector can be controlled individually in real time, enabling the system to actively stabilise pitch and yaw in real time. The receive beams are also stabilised for roll movements in real-time. The result is a uniform and dense survey pattern which leaves no gaps or holes uncharted and no objects missed - even in poor weather conditions.

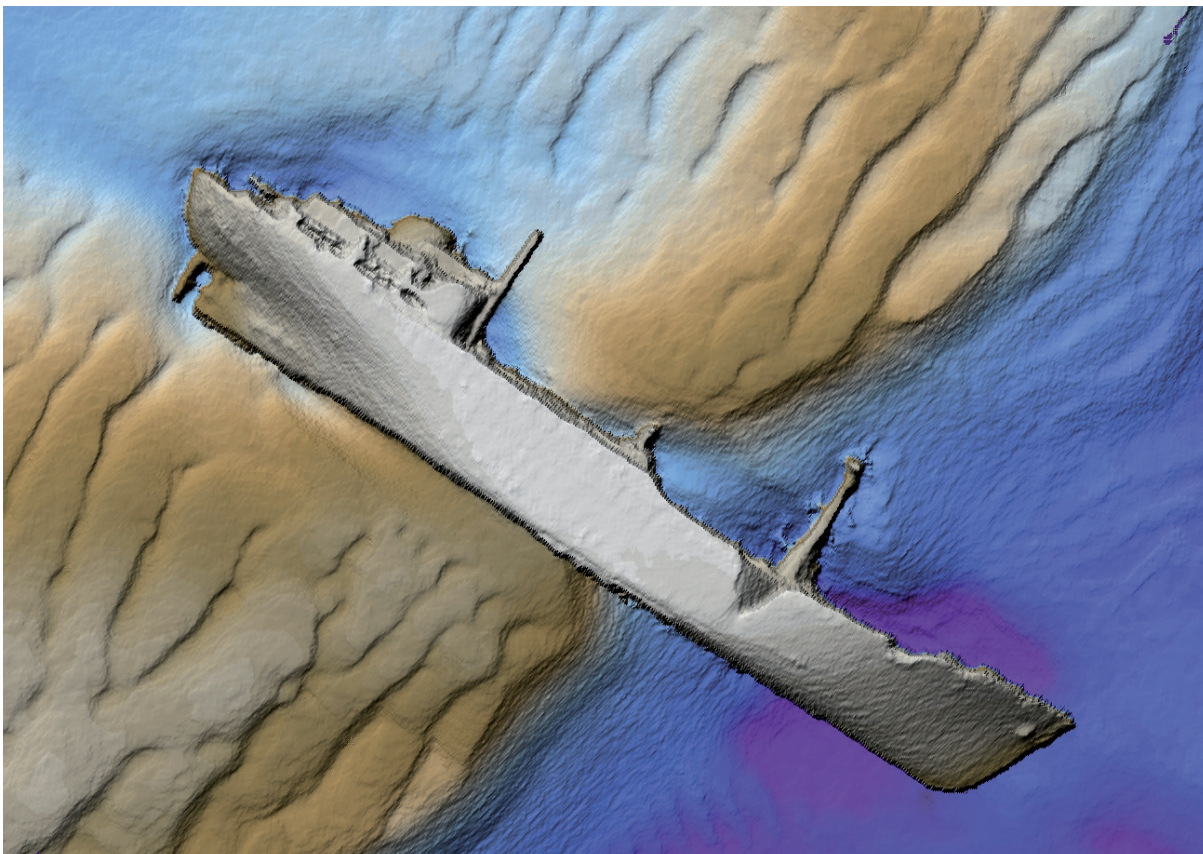
Depth compensation

All beams are compensated in real-time for heave, roll, yaw and pitch movement of the vessel. This feature enables the system to measure and log the correct depth.

Near field focusing

The system applies beam focusing to both transmit and receive beams in order to obtain the maximum resolution inside the acoustic near field. During transmission, focusing is applied individually to each transmit sector to retain the angular resolution and during reception dynamic focusing is applied to all receive beams.

EM 710 image of MV Hægh Aigrette at 25-42m depth.
Courtesy of UK Maritime and Coastguard Agency.
Data acquisition, processing & visualisation by Fugro OSAE.



FM Chirp

All EM® systems utilise both CW and FM Chirp. FM Chirp is used in order to increase the range without sacrificing resolution. For example, a 12ms FM pulse equals to a 600us CW pulse in terms of resolution, but with FM Chirp the transmit power is increased by 13dB.

Dual swath

In dual swath mode the systems generate two transmit swaths per ping resulting in twice the number of soundings given per ping. This gives a much denser profile of the seabed even with a narrow transmitter or when surveying at high speed, leaving no gaps in the survey or lost targets.

High density beam processing

In high density mode more than one detection is derived independently from each beam. This is achieved by using more information from the phase detection curve resulting in a much higher resolution. The footprint is reduced to less than 30% in the outer beams.

Seabed Image

All EM® multibeam echo sounders produce and store seabed image data simultaneously.

Water column and extra detection

All systems are able to generate and log water column data. Water column (WC) data can either be logged together with the raw files or as separate WC files. In addition, the EM 2040 and EM 2040C can log simultaneous extra detections. Extra detections are soundings based on different user selectable criteria and logged to the raw file as extra soundings. In conjunction with WC data, these extra detections give the user valuable information about features in the water column, such as the mast of a wreck or anchor chains.

Seafloor Information System (SIS)

SIS is the standard software package for the EM multibeam echo sounders. The software includes an extensive set of graphical displays for data quality control, all necessary operator controls for setting up and running the system, data logging and system testing, as well as system calibration and other required tools. SIS supports online, real-time data cleaning to improve the overall survey efficiency.

The full range of EM Multibeam Echo Sounders available from Kongsberg Maritime.



WORKING IN SHALLOW WATERS

A good knowledge of shallow water bathymetry is needed to manage navigation channels, ports, harbours, lakes and dams. It is also essential to archaeological and construction surveys, cable landfalls and hydrodynamic modelling.

Multibeam echo sounder systems must be able to operate on shallow draft vessels, be easy to deploy, easy to use and produce clean data to provide accurate results quickly. Kongsberg Maritime delivers integrated systems for topographic and bathymetric measurement.

Our systems can include multibeam bathymetry for mapping the seabed and subsea structures and a marine laser scanner for mapping shorelines.

Third party software integration

The EM 2040, EM 2040P and EM 2040C can be integrated with third party topside software such as HYPACK®, EIVA®, QINSy®, Triton® and MB-Systems. Through third party software, the system can be easily integrated with third party laser scanners and other sensors. Subsequently, our delivery can include a multibeam for mapping the seabed and subsea structure and a marine laser scanner for mapping of shorelines, quay walls, bridges and other constructions.

Extra Detection

A new feature available on all systems that use EM 2040 technology is Extra Detection. This enables the user to identify, classify and map objects above the seafloor and in the water column, i.e. the shallowest point on a shipwreck.

EM® 2040

The EM 2040 is a flexible multibeam echo sounder for very high resolution bathymetry. It surpasses even the strictest requirements set by the survey industry. It is a very high resolution wide-band system for any shallow water application. It can be fixed or temporarily hull mounted, over the bow or side mounted and integrated on ROV, AUVs and ASVs.

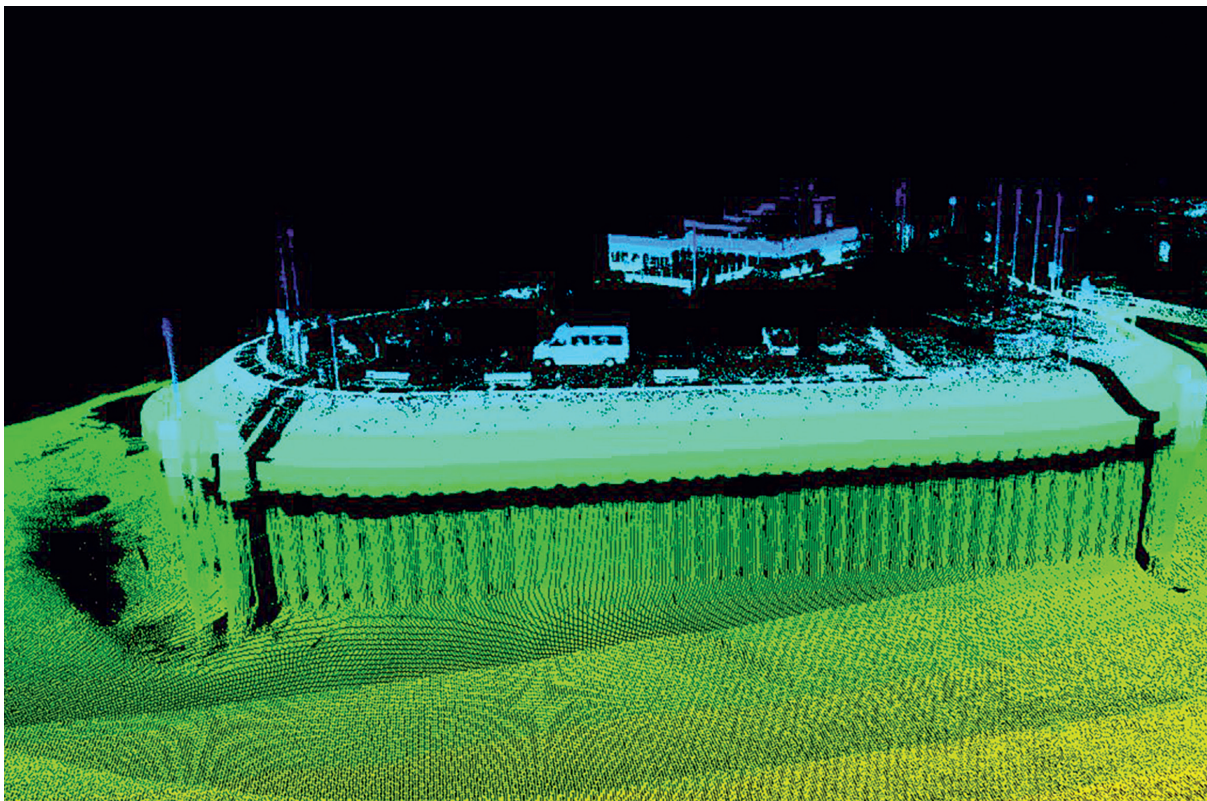
For shallow water applications an extra RX (receiver transducer) can be added for increased swath coverage, giving a dual RX configuration. This will increase the coverage to up to 10 times the water depth, while with a single RX the coverage will typically be 5.5 times the water depth. In very shallow waters, a swath width of up to 14-15 times the water depth has been achieved under favourable conditions (noise and seabed dependent).

By utilising the much longer FM Chirp pulses, the maximum depth capability is 600m with a maximum swath coverage of up to 850m.

The bandwidth used by the system ranges from 200 to 400kHz which allows it to operate effectively with very short pulse lengths down to 25 ms. With the sampling rate matching the pulse length, the accuracy can be expected to be better than 10mm (ct/4).

The system can be delivered with different transducer sizes for different resolutions, either as an 0.7 x 0.7 (TX x RX) degree system or for maximum resolution as an 0.4 x 0.7 degree system. The transducers are depth rated down to 6000m as standard.

EM 2040 using QINSy and RIGL laser at Vooraanzicht IJmuiden. Image courtesy of GeoPlus Holland and QPS.



EM® 2040P

The EM 2040P is a highly portable, shallow water multibeam echo sounder based on EM 2040 technology. Designed for easy transport and quick deployment on any vessel of opportunity, the system offers survey performance up to and exceeding the IHO-S44 special order and the more stringent LINZ specification. As such, it is an ideal for any application, from high resolution mapping and inspection to shallow water surveys.

The operating frequency range for the EM 2040P is from 200 to 400 kHz. This allows a great deal of choice when selecting the best frequency for the application; 300 kHz for near bottom, 200 kHz for deeper waters, and 400 kHz for very high resolution inspection.

Due to the large operating bandwidth available the system has an output sample rate of more than 60 kHz, this allows the system to operate effectively with very short pulse lengths. By utilising both CW and FM chirp pulses, the system can achieve a much longer range capability whilst maintaining high resolution. Due to a highly sophisticated beam-former, the system produces the cleanest real-time data of any multibeam available today; almost no data processing is necessary.

The EM 2040P can also be delivered with dual swath capability giving a sufficient sounding density along track at a high vessel speed. This allows faster, more efficient and cost reduced operations.

The system comes with a new, small and portable splashproof Processing Unit.

EM® 2040C

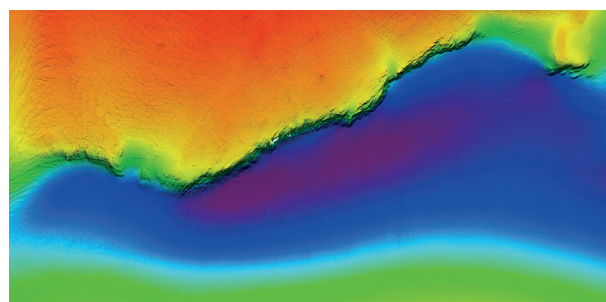
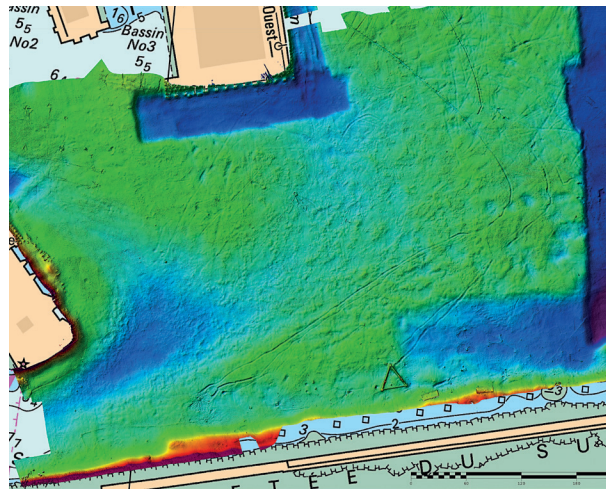
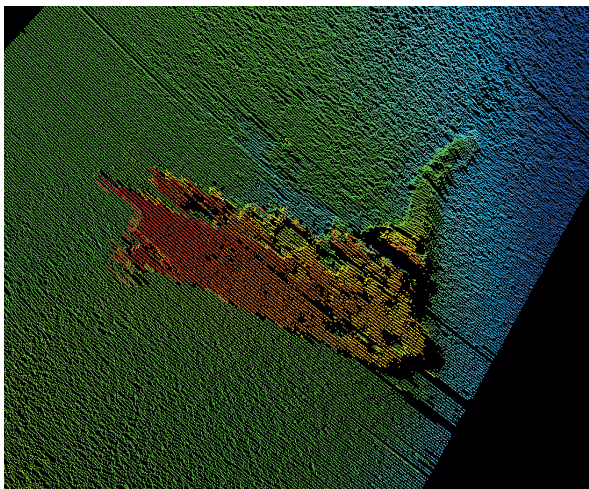
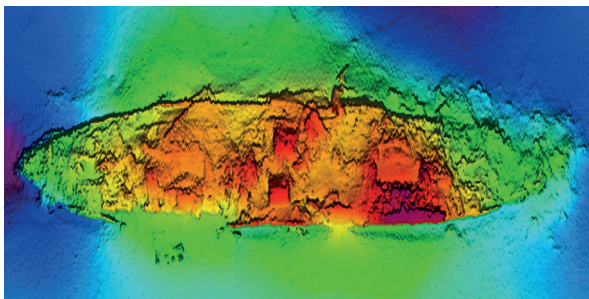
The EM 2040C is a compact version of the EM 2040 system, designed for compactness and to provide a portable solution for shallow water applications. The system has an operating range of 0.5 to 500m. The frequency range is from 200 - 400 kHz in 10 kHz, user selectable steps.

In shallow waters an extra sonar head can be added for increased swath performance and will increase the coverage up to 10 times the water depth. A single head will typically cover 4.3 times the water depth. In very shallow waters, a swath width of up to 14-15 times the water depth has been achieved under favourable conditions (noise and seabed dependent).

The transmitter and receiver are integrated in a common sonar head that has the same dimensions as the EM 3002. These small heads are suited to permanent or portable deployment on the hull or over the bow or ideal for installation temporary on very small boats or vessel of opportunity or ASV.

The transducers are depth rated down to 50m, but a pressure-rated sonar head for 1500m is available for installation on ROVs and AUVs.

EM 2040P results - From top left clockwise: 1. Bay Wreckage, 2. Harbour Survey, 3. River bay, 4. Finding the Loch Ness Monster. Images 1, 2 & 3 courtesy of SHOM, France



GEOSWATH PLUS

KONGSBERG GeoSwath Plus systems acquire wide swath bathymetry and high resolution side scan data simultaneously. The use of phase measuring bathymetric sonar technology yields wide sea floor coverage, making GeoSwath Plus a highly productive survey tool for shallow water environments.

Depth information is limited only by the strength of the signal that is backscattered from the sea floor, enabling swath coverage of up to 12 times the water depth. The co-registered and geo-referenced side scan data can be normalised and classified using the GeoTexture software package. It makes use of beam pattern, motion

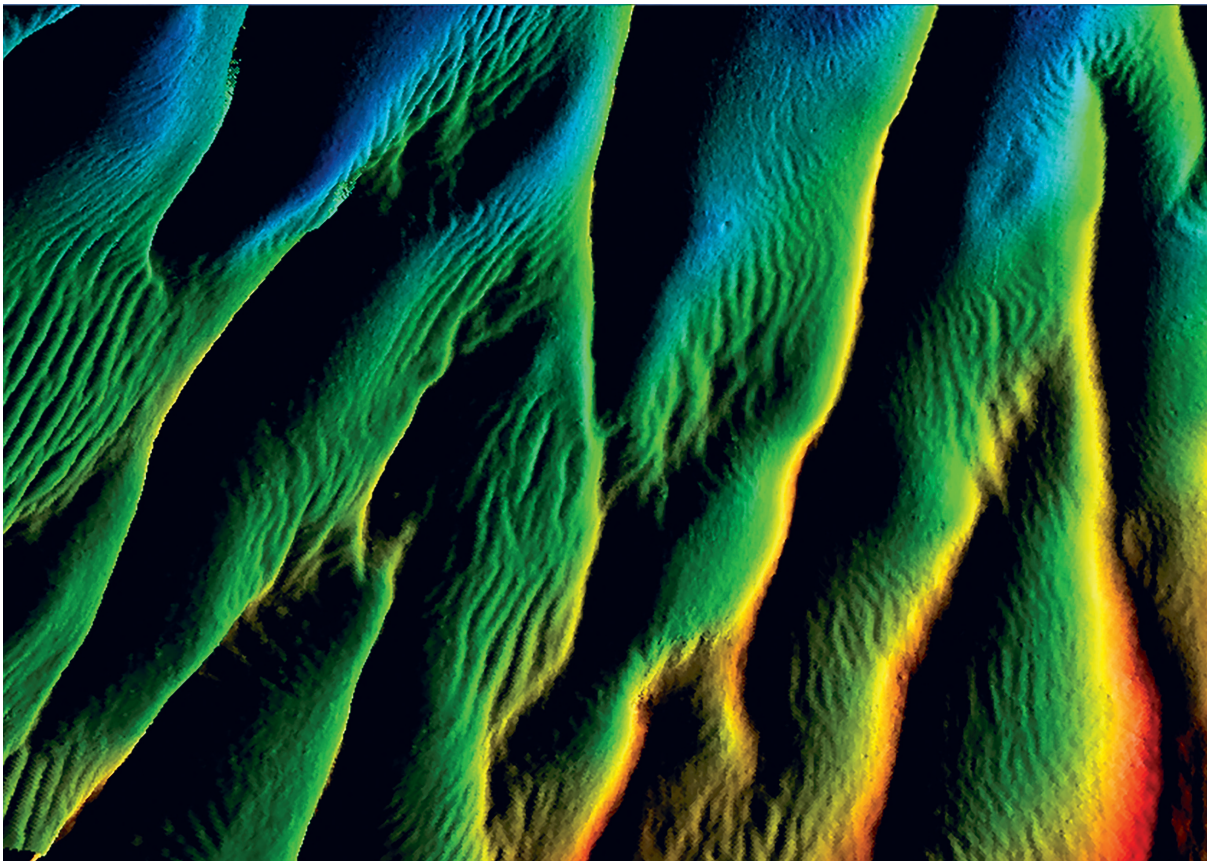
data and bathymetry information to compute calibrated backscatter values, which allow reliable interpretation and classification of seabed types.

The system can be deployed on dedicated survey vessels and vessels of opportunity in over-the-side, bow, moon pool or hull mounted configurations.

GeoSwath Plus Compact: A portable solution

GeoSwath Plus Compact is the portable system solution specifically designed for small craft operation. It consists of a compact lightweight dual transducer head and a water protected compact deck unit supplied by 24 VDC. The system is operated via a rugged laptop computer.

GeoSwath Plus (500 kHz) data imaging ripples from a river survey. Image by the Canadian Hydrographic Service.



M3® MULTIMODE MULTIBEAM SONAR

Kongsberg Mesotech's proven M3 MultiMode Multibeam Sonar is the only instrument in its price range that produces high-quality imaging records and 3D bathymetric datasets using the same sonar head.

Bathymetric multibeamsonars have different requirements than imaging sonars. A bathymetric multibeam sonar needs a wide opening angle across track, and narrow beam along track angle.

A forward-looking imaging sonar needs a wide beam across track and wide beam along track. This is why it's impossible for a conventional bathymetric sonar to function well as a forward-looking imaging sonar.

The M3's innovative design solves this technical challenge by using two sets of complementary transducers in the same head. The M3 generates both imaging and swath data in the same head. Point it down for bathymetric measurement; point it forward with a slight downward tilt for sea floor imaging; point it forward for obstacle avoidance, point it sideways for structural inspection or vessel hull inspection.

The M3 system can be used for a wide range of applications such as shallow water surveying, pipeline profiling surveying, dredging monitoring and verification, engineering inspection of small ports and harbours and outflow and cooling water intake inspections of dams, bridges and piers.

M3 Sonar - Bathymetric Capture, Maqtacquac Headpond Survey. Image courtesy of UNB-Ocean Mapping Group.



WORKING IN MEDIUM TO DEEP WATERS

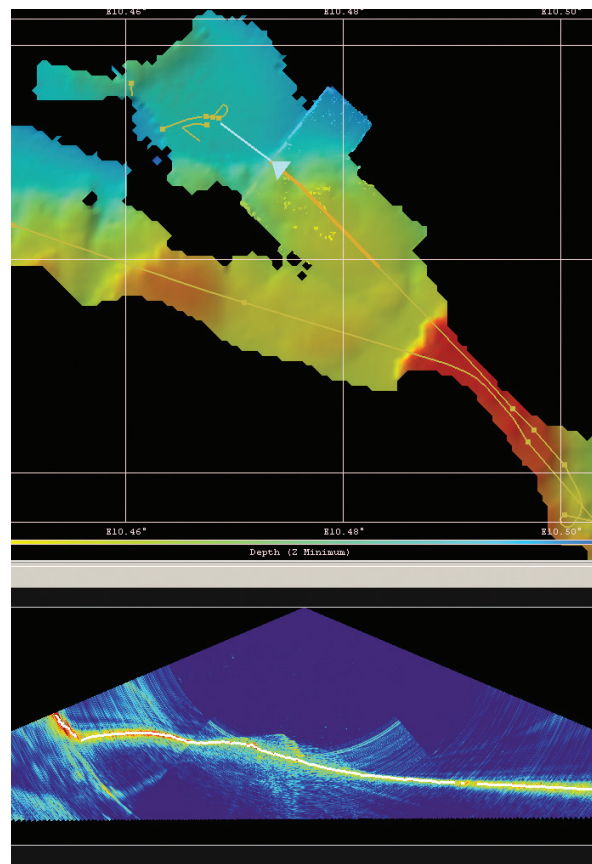
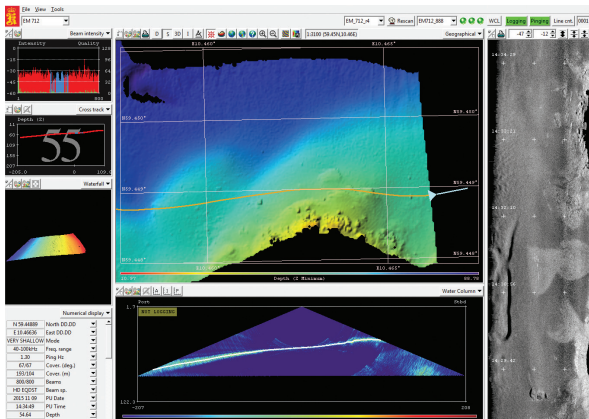
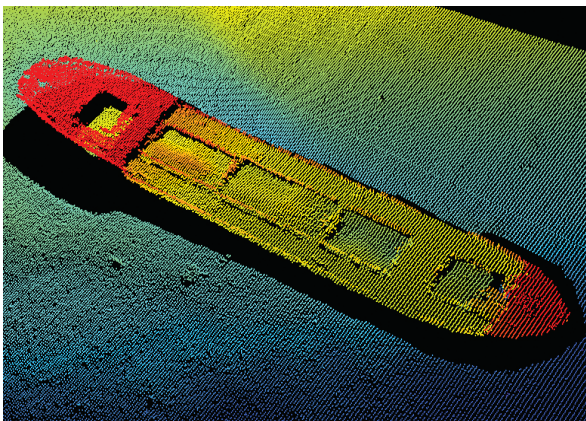
EM[®] 712

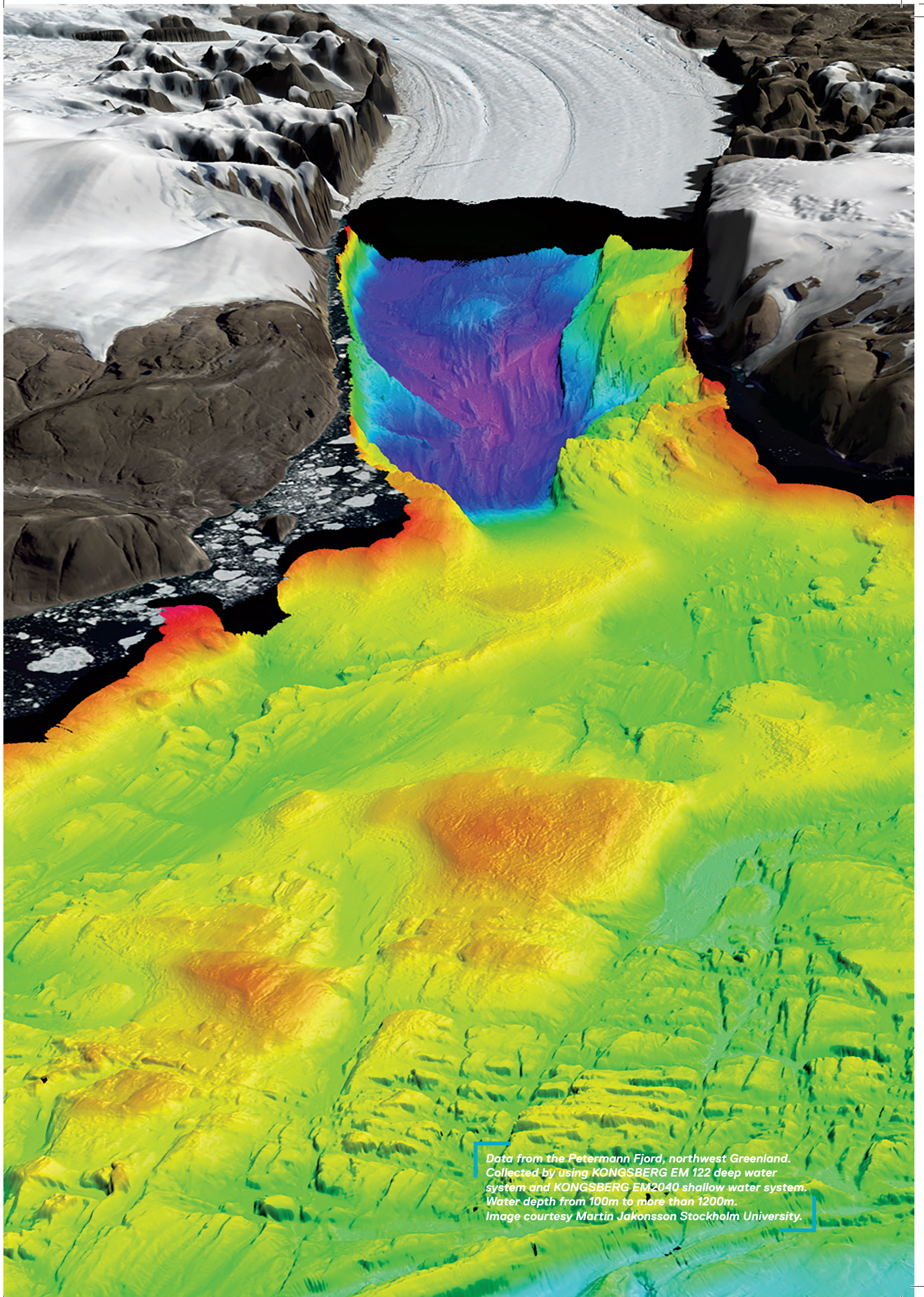
EM 712 is the next generation, high to very high resolution multibeam echo sounder system for shallow to medium water depths and takes the technology to the next level. The EM 712 has a much greater range and swath coverage and includes more features than the standard EM 710. The EM 712 introduces a 0.5 x 0.5 beam opening angle to the market - a world first.

The EM 712 has a bandwidth from 40kHz to 100kHz, and due to the new receiver transducer technology and new low-noise electronics, the acquisition depth has been increased to more than 3500m with an across track coverage up to 5.5 x the water depth. This enables a maximum coverage of close to 4200m (dependent upon the size of the arrays).

The system configuration can be tailored to the user requirements, allowing for beam widths from 0.25x0.5 degrees to 2x2 degrees and a selection of different models; a full performance version which utilises both FM Chirp and CW pulses, a shallow version which utilises CW pulses only, and a reduced depth version. Both the shallow and the reduced depth versions can be easily upgraded to full performance.

Below, clockwise from the top left:
1 - EM 712 - Wreck off Langøya (0,5 x 0,5 degrees)
2 & 3 - Screen capture of EM 712 data





Data from the Petermann Fjord, northwest Greenland.
Collected by using KONGSBERG EM 122 deep water system and KONGSBERG EM2040 shallow water system.
Water depth from 100m to more than 1200m.
Image courtesy Martin Jakonsson Stockholm University.

EM® 302

The EM 302 is a well proven multibeam system for surveys starting at depths of 10m to beyond the continental rises down to 7000m. The maximum achievable swath width is about 8km. Smaller transducers and compact electronics make installation easy, and the system is offered with different array sizes and beam widths.

EM® 122

The EM 122 is the standard for all vessels requiring a multibeam system for full ocean depth surveys. With its unsurpassed resolution, coverage and accuracy, it is suited to detailed sea floor mapping from depths of less than 50m to down to 11000m.

The operating frequency is 12kHz and by utilising FM chirp the system boasts a 25% larger coverage than the EM 120, and up to four times the resolution in terms of sounding density.

Over 35km swath width is achievable, and from customer acceptance tests it has been proven that the system can provide coverage of more than 40km under favourable conditions.

The system is offered with different array sizes for flexible installation, from 2 x 4 degrees as an entrance model to 0.5 x 1 degree as the outermost version.

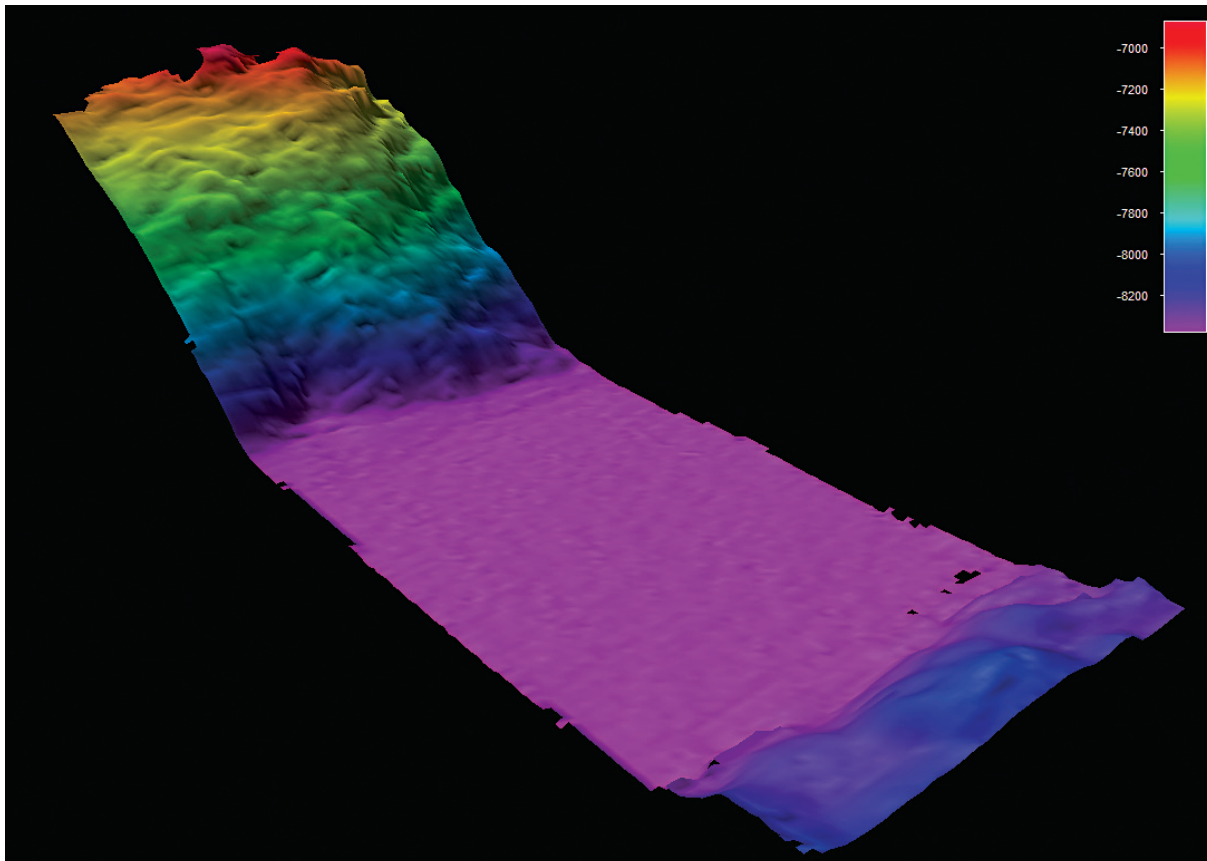
Both the EM 302 and the EM 122 can be extended to include sub bottom profiler capability by adding a separate low frequency transmitter array. These extensions are known as the SBP 300 and SBP 120 respectively, both of which are very narrow beam width sub bottom profilers.

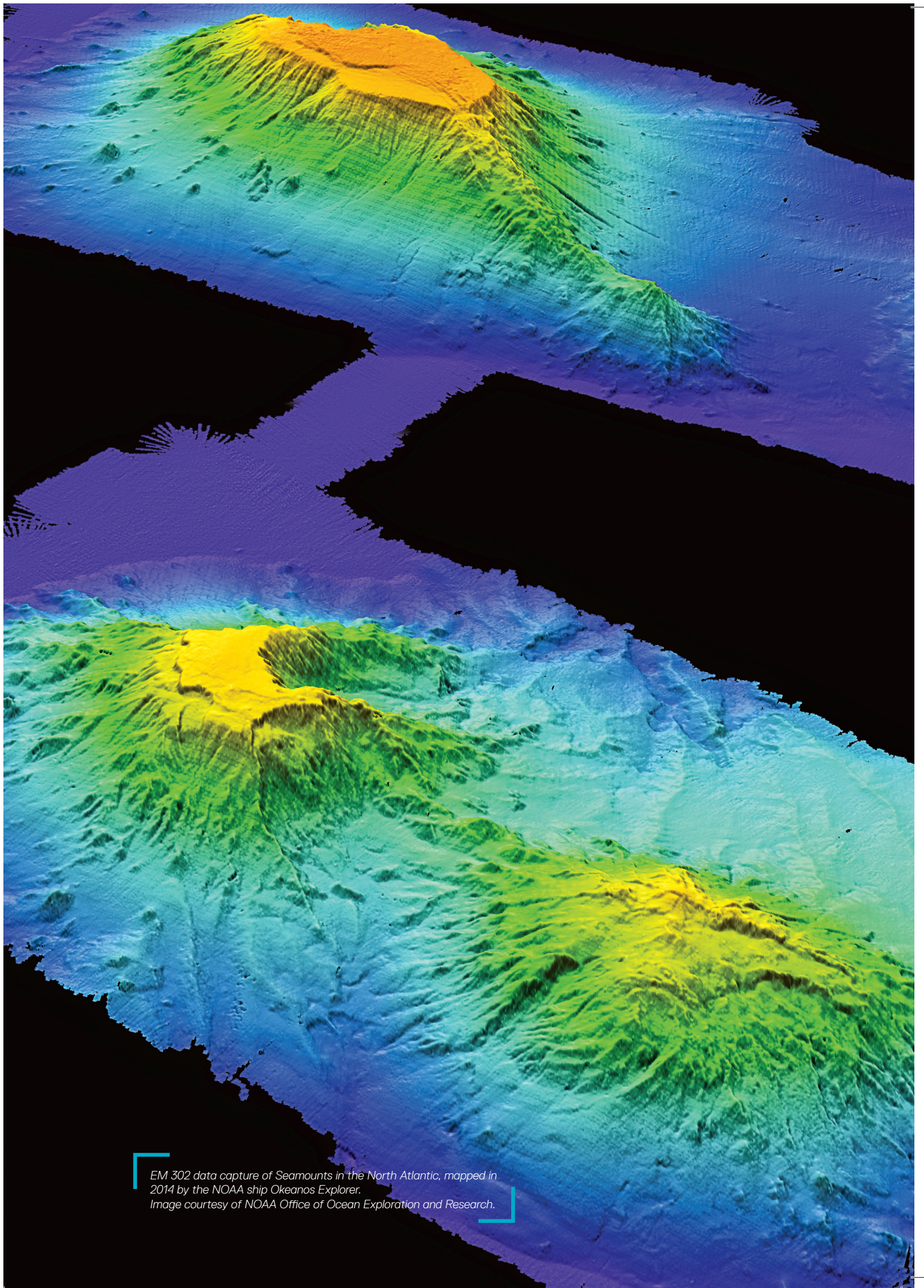
Ice Breakers and Polar Vessels

For ice breakers and polar vessels the EM 302, EM 122, SBP 300 and SBP 120 systems can be delivered with ice windows to protect the transducers. The strength of the delivered ice window is dependent on the vessel class. For ice breakers the windows are certified to withstand a pressure of 26 tons per 10 x 10 inches.

Due to the higher frequency and smaller transducer design the EM 712 can be delivered with special reinforced ice-protection transducers.

Below: EM302 - a Trench in Puerto Rico at 8400m depth.
Image courtesy of NIOZ





EM 302 data capture of Seamounts in the North Atlantic, mapped in 2014 by the NOAA ship Okeanos Explorer.
Image courtesy of NOAA Office of Ocean Exploration and Research.

MARITIME BROADBAND RADIO (MBR)

Operating as a maritime 'Information Highway', Maritime Broadband Radio (MBR) connects crews and their vessels using a high speed, high capacity digital communication channel with 'Fast Track' priority options.

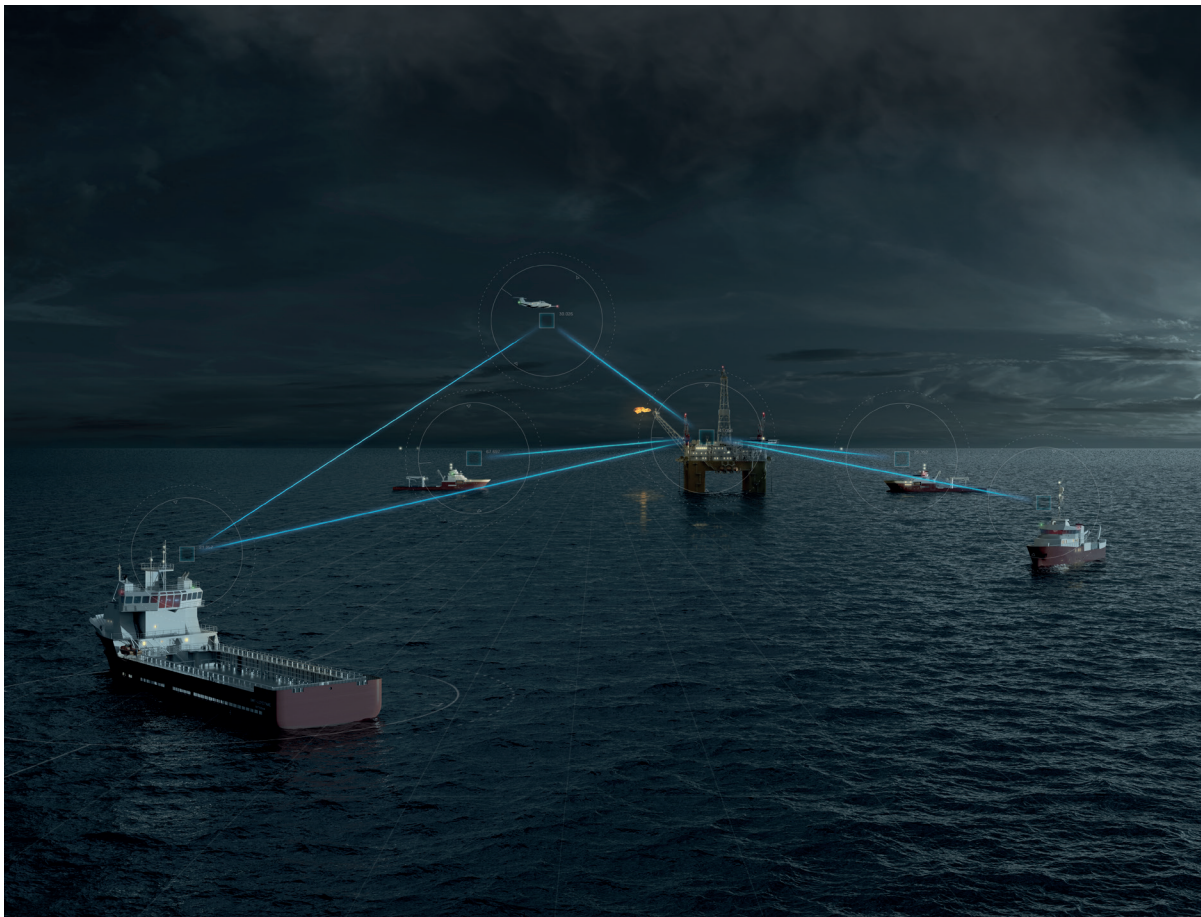
Optimised to securely carry a diverse array of operational information spanning from real-time video streams to systems data, MBR enables remotely situated teams to work together seamlessly, co-ordinating systems and activities for optimal performance, safety and operational success.

Information from several sensors on separate vessels can be shared in real time, allowing the operators to communicate and make decisions based on a common operational understanding.

More efficient data acquisition is made possible with the main vessel receiving data streams from a launcher utilising MBR. The hydrographer can operate several launchers to secure optimum survey result.

MBR allows for bi-directional connectivity between assets with the utilisation of IP technology. The use of end-to-end IP connectivity provides cost efficient integration and an interoperable solution for seamless data exchange.

The novel antenna design represents a breakthrough in wireless data exchange, with unsurpassed capability to transfer data in even heavily obstructed areas. The consistent dataflow maximises efficiency in applications and operations, and minimises the risk of interruption or delay of operations due to lack of communication.



REMOTE SERVICES

K-Remote uses online systems and health monitoring to provide KONGSBERG customer support with remote access to ensure reliability.

The global network solution consists of two groups of devices, communication hubs and node network devices. All network traffic between network devices are encrypted. Any IP-based communication link can be utilised as a communication carrier.

Online service for instant analysis and assistance:

- operational support and guidance
- inspection of on-board systems and interfaces
- preparation and investigation prior to service visits
- remote update of on-board systems.
- remote commissioning



SCANNING SONARS

Scanning sonar for underwater inspection

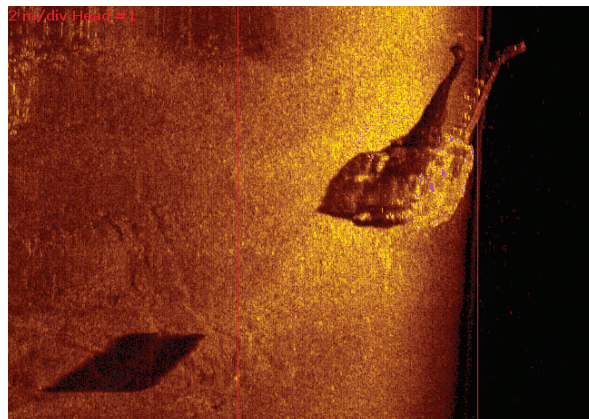
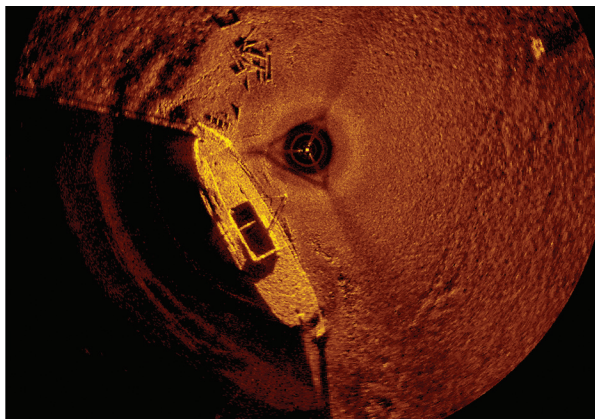
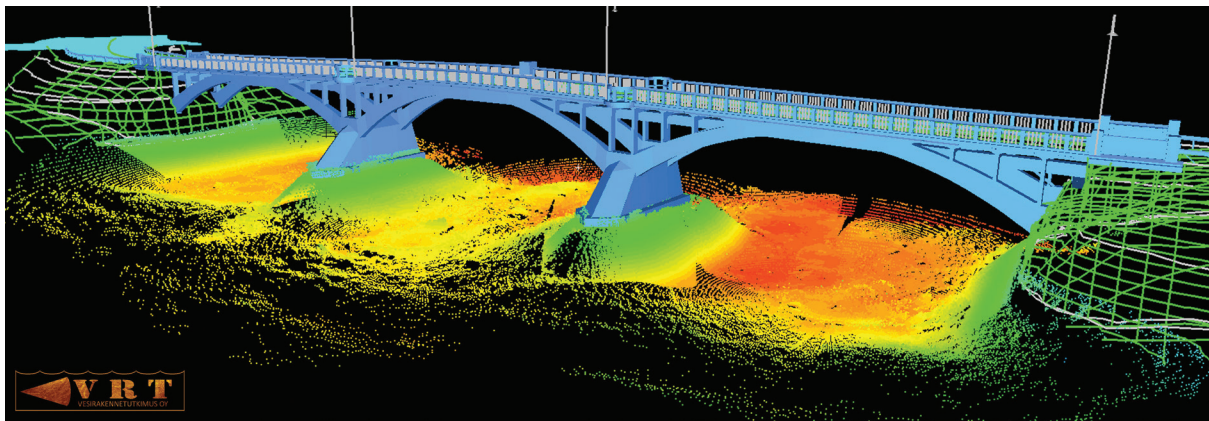
Underwater inspection of man-made structures is vital as they age. In addition, water currents, corrosion, and damage from storms and vessels may impact structure integrity.

Diving inspections are often challenged by high current, deep water, lack of visibility and debris accumulation around the structure. In addition to preventing the diver from completing a thorough inspection, debris

build-up around bridge piers is potentially one of the most dangerous conditions the inspection diver faces; It introduces the possibility of entanglement, and even worse, diver entrapment if the debris moves.

KONGSBERG's range of high resolution imaging and profiling sonar heads continues its leadership in visualising underwater structures (such as bridges, docks, piers and dams, etc.) and is used in a multitude of underwater construction and survey applications.

Top: 3D point cloud of a bridge. Courtesy of VRT Finland.
Bottom left: 18 m vessel. Courtesy of Nautilus Marine Group.
Bottom right: PulSAR data image showing a submerged helicopter.



Side scan sonar

Side scan sonars make it possible to efficiently search large areas. Our systems provide high resolution images of the seafloor that are ideal for mapping shipping hazards, detecting debris, search and recovery operations, monitoring underwater structures, archaeological research and mine counter measure activities.

PulSAR

PulSAR acquires high resolution acoustic images of the seabed. The system is deployed on a rugged towfish in order to get closer to the seafloor and ensure the grazing angles needed to achieve high quality data. A water protected deck unit with in-built GPS and a small, cable hand reel allow operation from small open vessels. Large areas can be surveyed efficiently revealing small objects and structures in great detail. The system uses a frequency range of 550kHz to 1MHz. Within this bandwidth source signals, both FM and CW, can be selected in order to optimise the range and resolution for the given survey task.

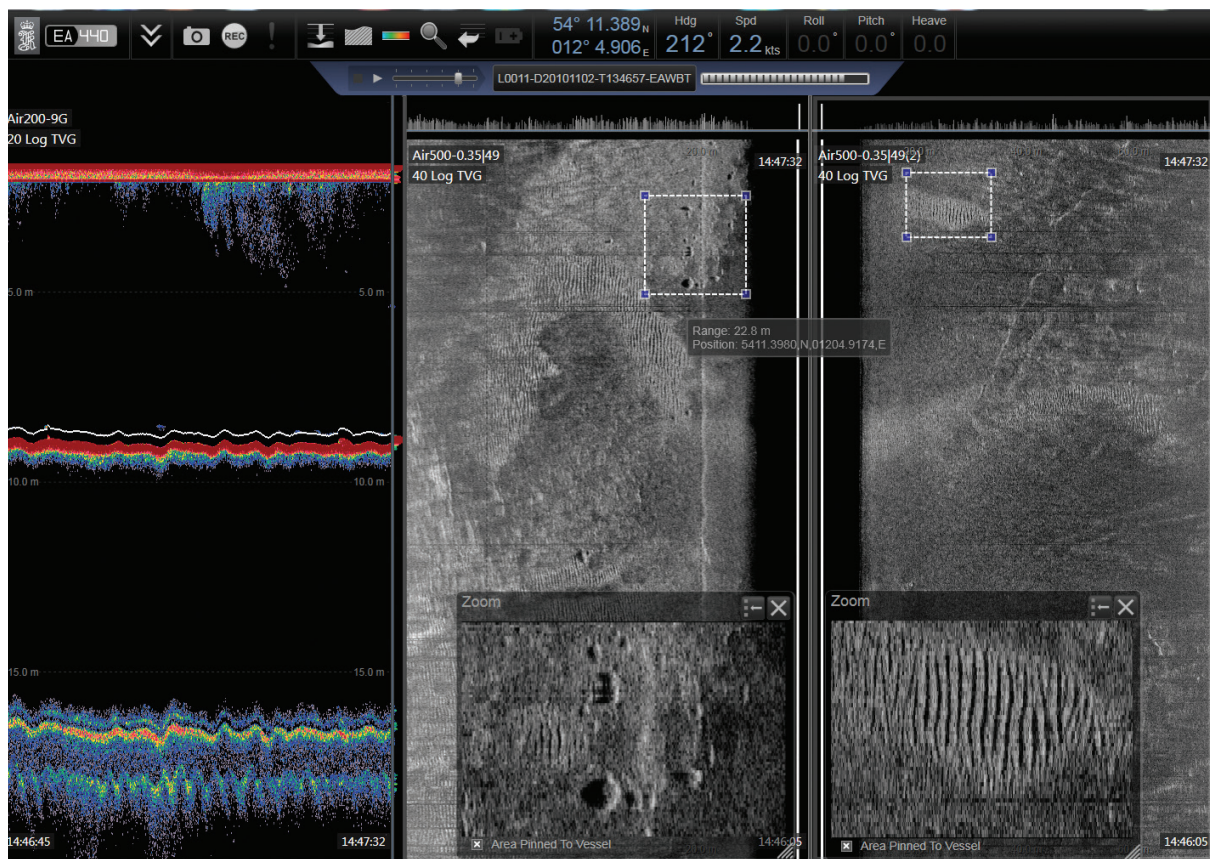
Combined systems

Side scan sonar is available for the EA440 and EA440 SP hydrographic echo sounders. These combined systems are ideal for surveying shallow water areas such as harbours, or for fixing the geographic location of detected objects.

The side scan sonar is available in a single and dual transducer configuration. The system can be fixed mounted in the hull or over-the-side and can easily be installed on any vessel of opportunity. A vessel installation eliminates the need for a towing sidescan.

One or several vertical channels can be used for normal echo sounding in addition to a dual sidescan.

EA440 with side scan: 1 vertical channel 200kHz, dual side scan 500kHz with zoom area for inspection of objects (left) and morphology (right)



SYNTHETIC APERTURE SONAR

HISAS[®] 1032 is a High Resolution Interferometric Synthetic Aperture Sonar system capable of providing very high resolution images and detailed bathymetry of the seabed.

The system was originally developed for demanding military mine countermeasure operations, where there is a need to detect and classify small objects on the sea floor in a challenging, clutter filled environment. The sonar is installed on board HUGIN, a medium size AUV in Kongsberg Maritime's family of AUVs.

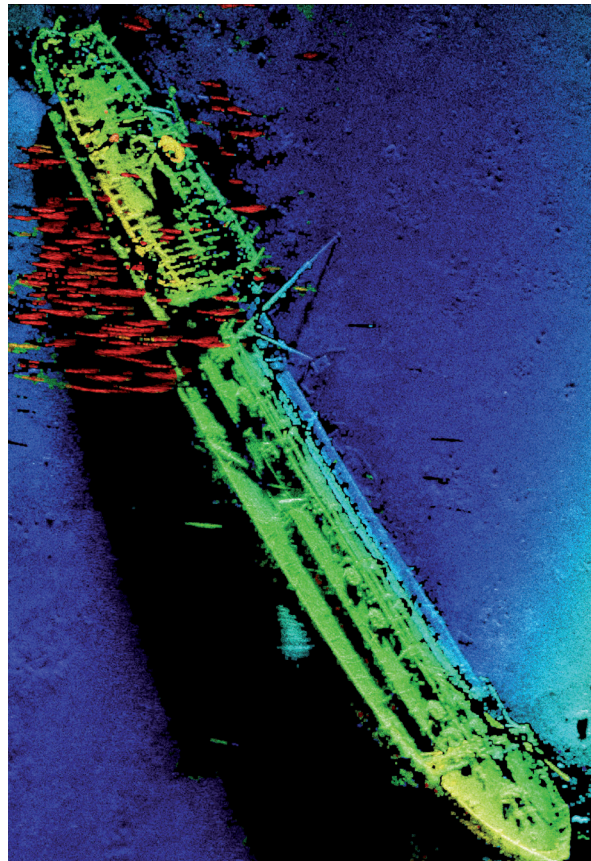
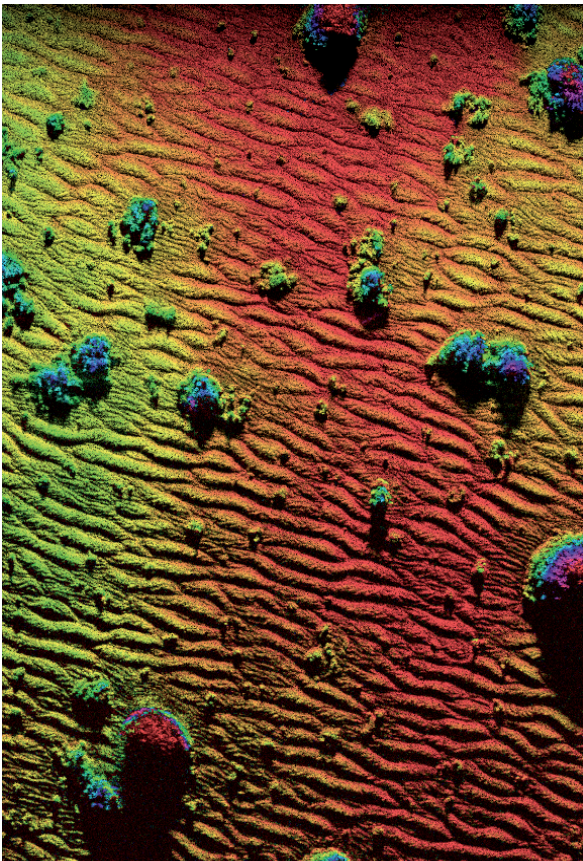
HISAS has a range-independent resolution of approximately 3 x 3 cm out to a distance of more than 200 m from both sides of the AUV at a speed of 2 m/s, which allows for detection and correct classification of mines and other small objects. It has a typical area coverage rate better than 2 km/hr.

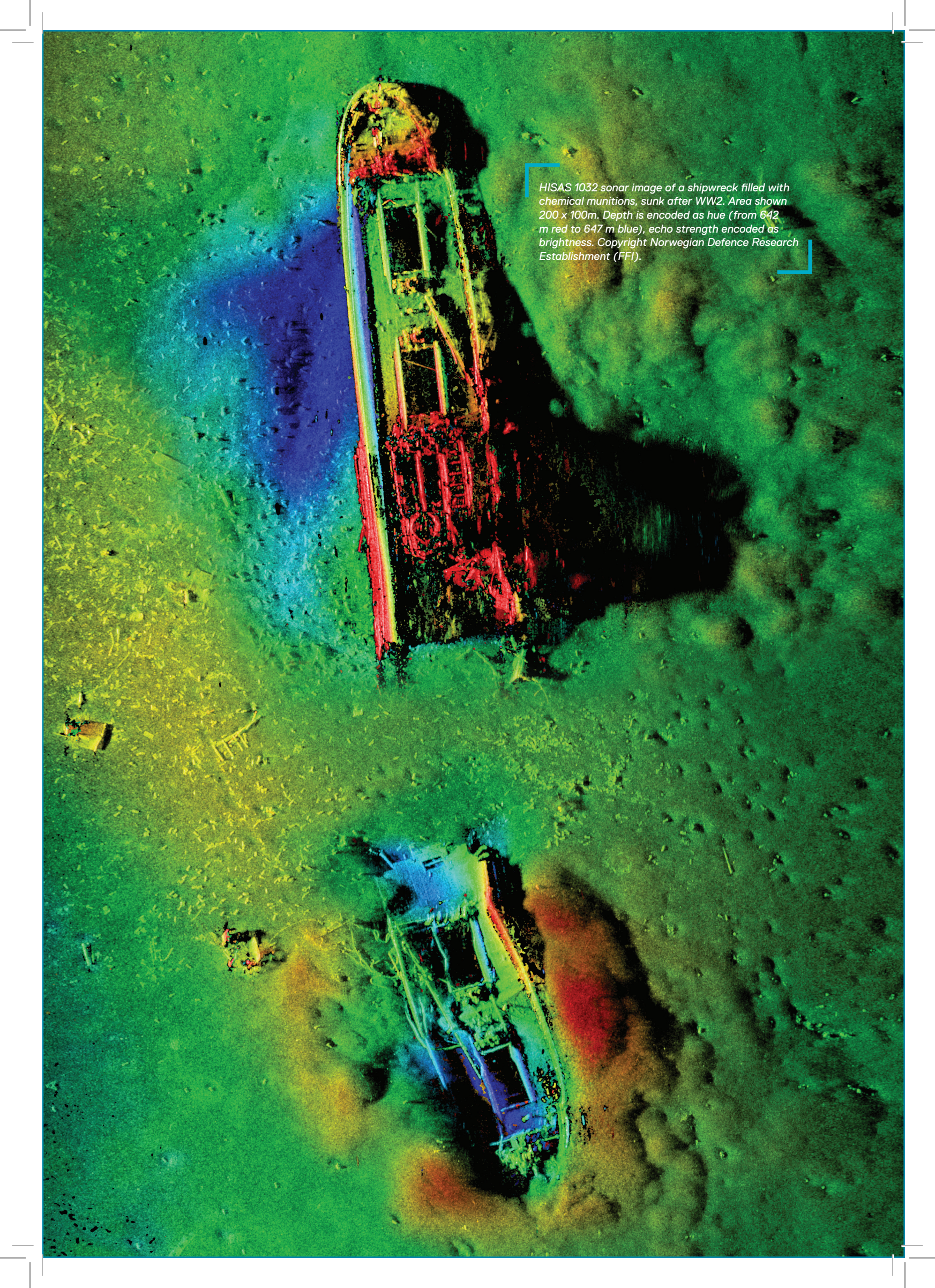
As the height map is generated at near image resolution, it is possible to generate bathymetric estimates both at side scan and full synthetic aperture sonar resolution. This allows rapid collection of large swathes of bathymetric information at low processing cost, while simultaneously providing extremely detailed bathymetric imagery for selected regions.

By merging HISAS 1032 side scan bathymetry with data from the EM 2040 multibeam echo sounder, a single swath of up to 20 times the altitude of the AUV above the sea floor can be generated. Kongsberg Maritime develops and manufactures the AUV, the aided inertial navigation system and the synthetic aperture sonar in-house. The result is smooth system integration, optimal performance and high quality data.

Below left: Coral and sand, collected in April 2011 near the Great Barrier Reef, Australia

Below: Norwegian tanker 'Holmengraa', sunk off the coast of Horten 28 December 1944 under an allied air-raid. Data collected 2012, imagery courtesy of FFI





HISAS 1032 sonar image of a shipwreck filled with chemical munitions, sunk after WW2. Area shown 200 x 100m. Depth is encoded as hue (from 642 m red to 647 m blue), echo strength encoded as brightness. Copyright Norwegian Defence Research Establishment (FFI).

SUB BOTTOM PROFILERS

Our sub bottom profiler systems (SBP) are ideal for identifying and characterising layers of sediment or rock under the sea floor, going beyond the capabilities of standard echo sounders. They are commonly used for geological surveys, dredging operations and locating objects such as pipelines.

All of Kongsberg Maritime's profilers have excellent penetration, high resolution and cover all depth ranges.

Options for versatility

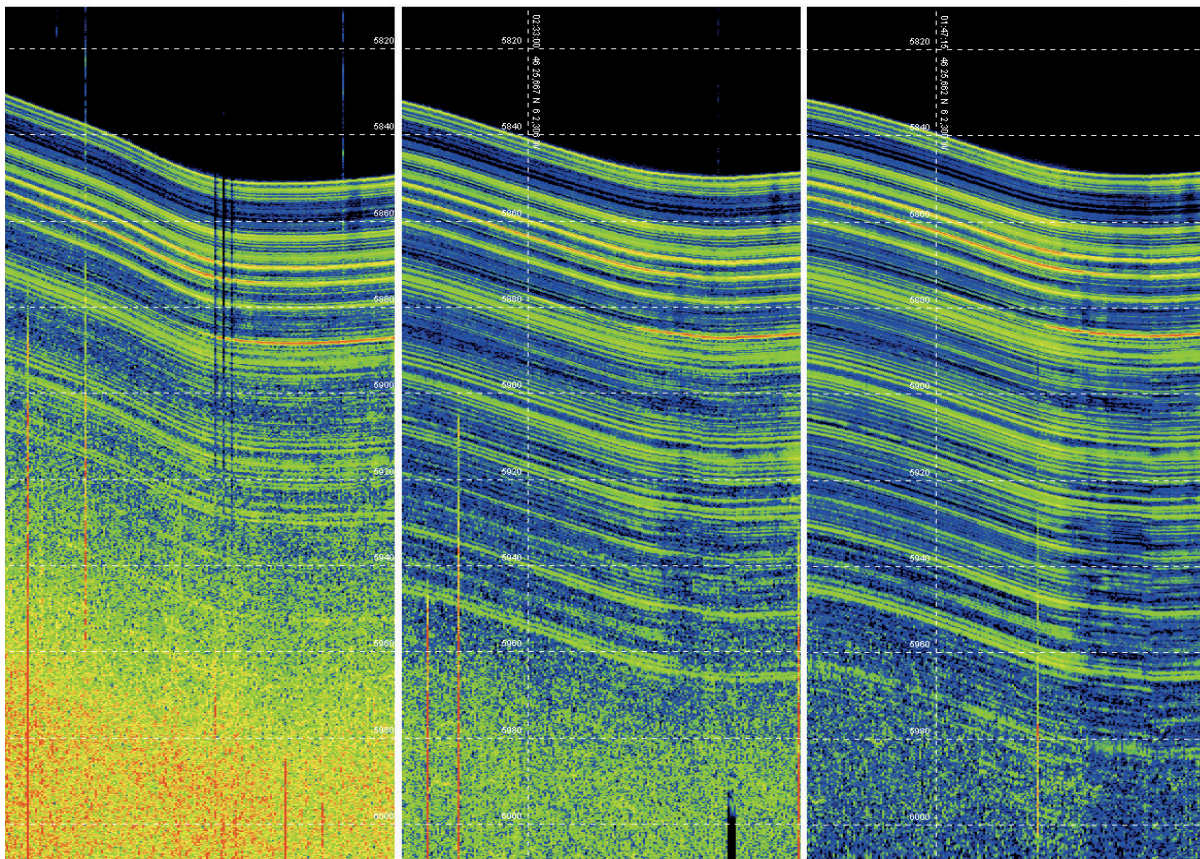
The SBP 120 and SBP 300 systems are commonly installed as an extension to the EM 122 and EM 302 multibeam echo sounder systems, and consist primarily of a separate low frequency transmitter transducer and a transceiver cabinet. The receiving transducer of both the EM 122 and the EM 302 is wide band, and can therefore also be utilised by the SBP 120 and SBP 300 respectively, thus enabling sub-bottom profiling capacity.

Sub-Bottom Profilers identify, characterise and measure layers of sediment or rock under the sea floor.

Both SBP systems have electronic roll, pitch and heave stabilised beams. The systems have significantly reduced beam widths compared to conventional sub-bottom profilers. This is achieved by having one linear transmit array mounted along the vessel keel and one linear hydrophone array mounted orthogonally to the keel. Using a large transmit array increases the source level due to the injection of more power without any risk of cavitation. This increases the directivity of the transmitter and improves the suppression of acoustic noise and reduces greatly the reverberation volume.

The SBP makes a fan of 11 narrow beams across-track per ping inside a 30 degree sector. This multibeam capacity is useful for finding and resolving specular returns in rough terrain, detecting buried objects and obtaining information about the angular response of sediments in the sea floor.

SBP 120 results showing the improvements made by decreasing the beam width at a depth of 4400 m. From left to right, beam widths are: 12, 6 and 3 degrees. Data copyright SHOM.



The end result is a 3D displays of sub-bottom sediments. All beams can be take into account the bottom slope.

The transmit waveform is a linear FM chirp ranging from 2.5kHz to 7 kHz, providing a maximum vertical resolution of approximately 0.3ms In addition, the system can use other pulses like CW, hyperbolic chirp and Ricker.

A high constant ping rate can be maintained even in deep waters via a multi-pulse operating mode. The system can be synchronised with the EM 122 or EM 302 multibeam echo sounders, and is offered as a 3, 6 or 12 degree system.

GeoPulse Plus - Digital technology

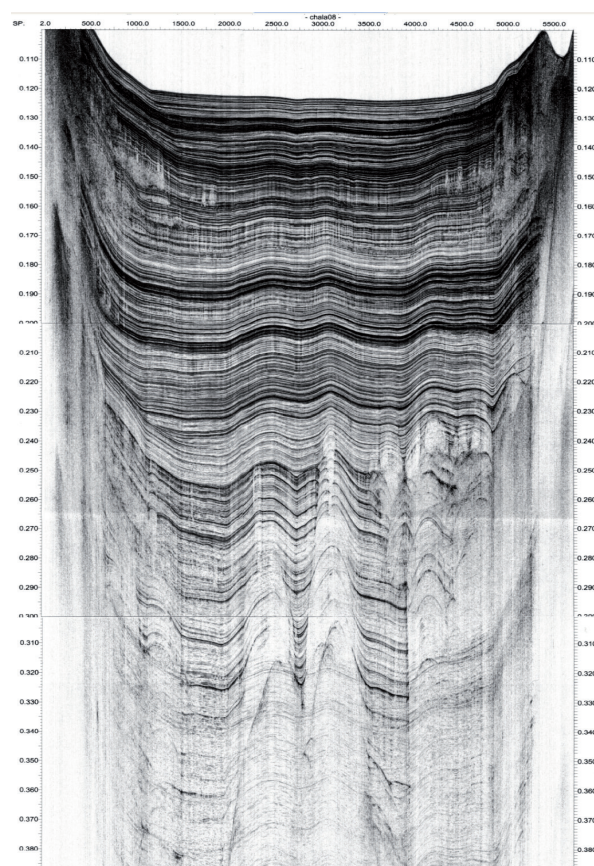
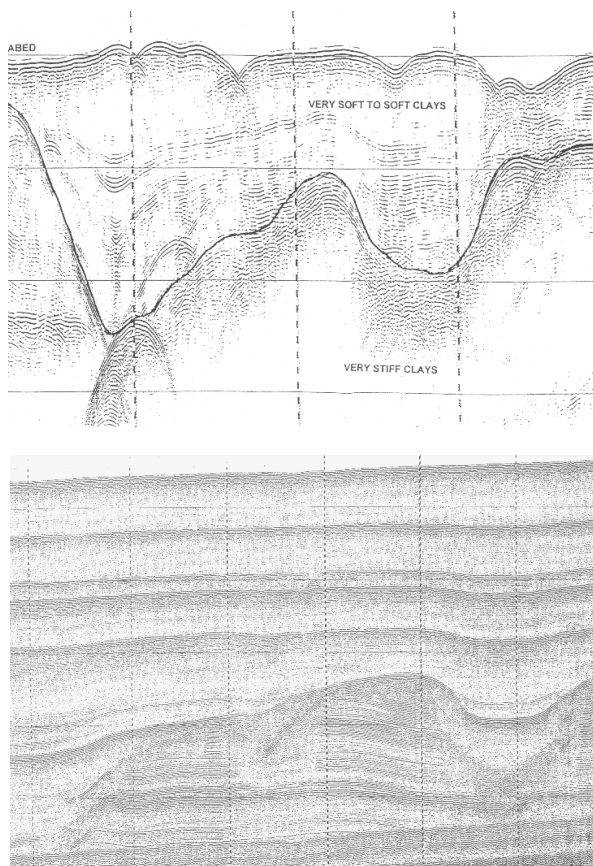
GeoPulse Plus is Kongsberg Maritime's high resolution digital sub-bottom profiler. Depending on the survey task, the source signal used can vary within the frequency band 1.5kHz to 18kHz. This allows for optimal resolution and sub-sea floor penetration whether it is used for mapping deep ocean geology, or determining the mud thickness in a silted harbour. Other options include the CW pinger waveform or FM chirp signals. The system can be deployed on the hull of dedicated survey vessels, towed to bring it closer to the target in deep waters or as a portable over-the-side system mounted on vessels of opportunity.

The system is operated directly from the deck unit or a laptop computer with an ethernet interface to the deck unit. The sonar electronics are mounted close to the transducers in all deployment options, and the signal is transmitted to the deck unit via a lossless digital connection. Data is acquired with the transmit transducers or alternatively with a hydrophone.

Below: GeoPulse Plus data, Lake Chala, Kenya. Data courtesy of Renard Centre of Marine Geology, Ghent, Belgium.

Left (Top): GeoPulse Plus imaging Paleo channels.

Left (bottom): GeoPulse Plus imaging stratified sediments offshore the Philippines



GeoChirp 3D - Higher resolution in 3D

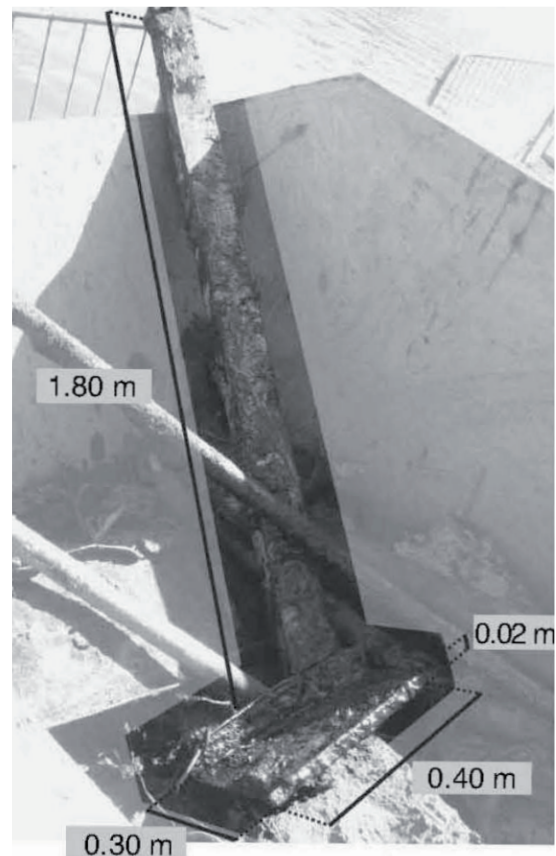
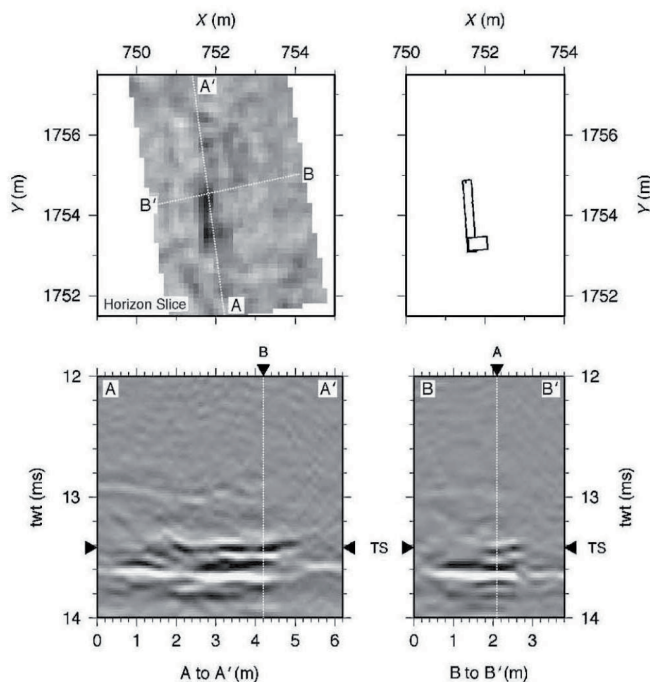
GeoChirp 3D provides three dimensional acoustic images of shallow, sub-seabed objects. It transfers the well established principles of conventional 3D reflection seismic technology, used in hydrocarbon exploration, to high resolution chirp sub bottom profiler technology. Typical applications include marine archaeology, pre-construction and piling surveys, mine countermeasure and unexploded ordnance operations and marine geology and geophysics.

All acoustic sources, hydrophone receivers and positioning components are incorporated into a surface tow body. This rigid frame can be deployed from small vessels.

The acoustic source array consists of four GeoPulse Plus transducers and 60 hydrophone arrays. RTK GPS positioning and heading antennas together with a motion reference unit (MRU) allow the determination of geo-referenced source and receiver positions.

The data acquisition deck unit combines seismic and navigation data capture in one system. It is controlled by a graphical user interface suited to survey planning and data quality control. Data is stored in SEG-Y format. Third party industry standard 3D seismic processing and visualisation software can be offered as part of the survey package.

The GeoChirp 3D images buried objects in great detail. Here, a wooden pole with a metal plate attached was detected, imaged and retrieved from a silted harbour basin.



Parametric Profilers

The TOPAS family of sub bottom systems are parametric profilers designed for high resolution profiling and object detection. The systems are designed around the parametric end-fire antenna principle that gives a high directivity and a low frequency beam from a small transducer area.

PS 18

The PS 18 operates in water depths from about 20m to full ocean depth with a penetration capacity of greater than 200m and a beamwidth of 4.5 degrees.

PS 40

The PS 40 is designed to operate from less than 5m to over 1000m, with a penetration capacity of more than 75m with a beamwidth of 3-5 degrees.

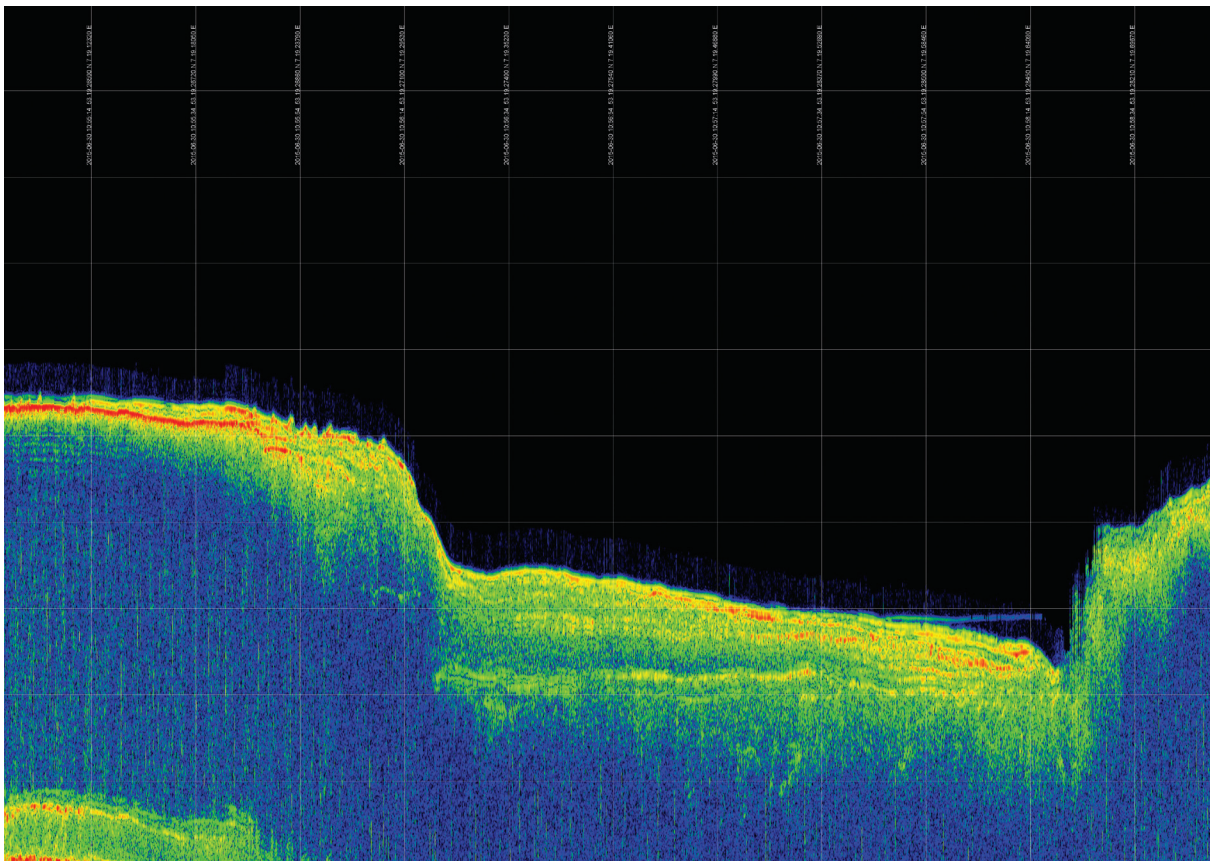
PS 120

The PS 120 is designed to operate from 2m to over 400m, with a penetration capacity of greater than 20m with a beamwidth of 4-6 degrees.

All TOPAS systems can be hull mounted with electronic roll, pitch stabilised beams, which make them an efficient tool in all kinds of accurate, high resolution survey operations.

They can optionally perform sequential beam scanning over a sector of up to 90 degrees generating a sub-bottom swath for building 3D displays of sub-bottom sediments.

A typical result from PS 120 from a sandy area off the west coast of Germany.



SINGLEBEAM ECHO SOUNDERS

Singlebeam echo sounders are used on a wide range of vessels, providing amongst other applications water depth information for navigation and surveying.

Kongsberg Maritime's EA series is the most comprehensive and high performance range of hydrographic echo sounders on the market. They can be adapted for any application and are available as single or multiple frequency units ranging from 10 kHz to 500 kHz. All channels are independently controlled but have simultaneous transmission.

The new EA series offers a completely new and intuitive operator software. In addition to raw data storage, the system can store XYZ, SEG-Y, and XTF echogram data as bitmap and annotation. The raw data can be used to replay and generate additional data.

Shallow water applications

The EA440 is a new single beam system based on wideband technology with operating frequencies from 30 kHz up to 500 kHz, with a range limited low frequency option. By utilising FM chirp the system has an increased range performance without sacrificing resolution.

A variety of highly efficient transducers are available to suit all operational needs, from extreme shallow (0.2m) down to 3000m water depths, as well as side-scan applications. Low frequency transducers, typically 10 and 15kHz may be supplied for sub-bottom light but with a maximum depth range of 300m.

Each wide band transceiver has up to four channels, and several units can be controlled from the same operating software. The EA440 system has a dynamic range of 160 dB with a non-saturating receiver, allowing the time varied gain to be applied in the software.

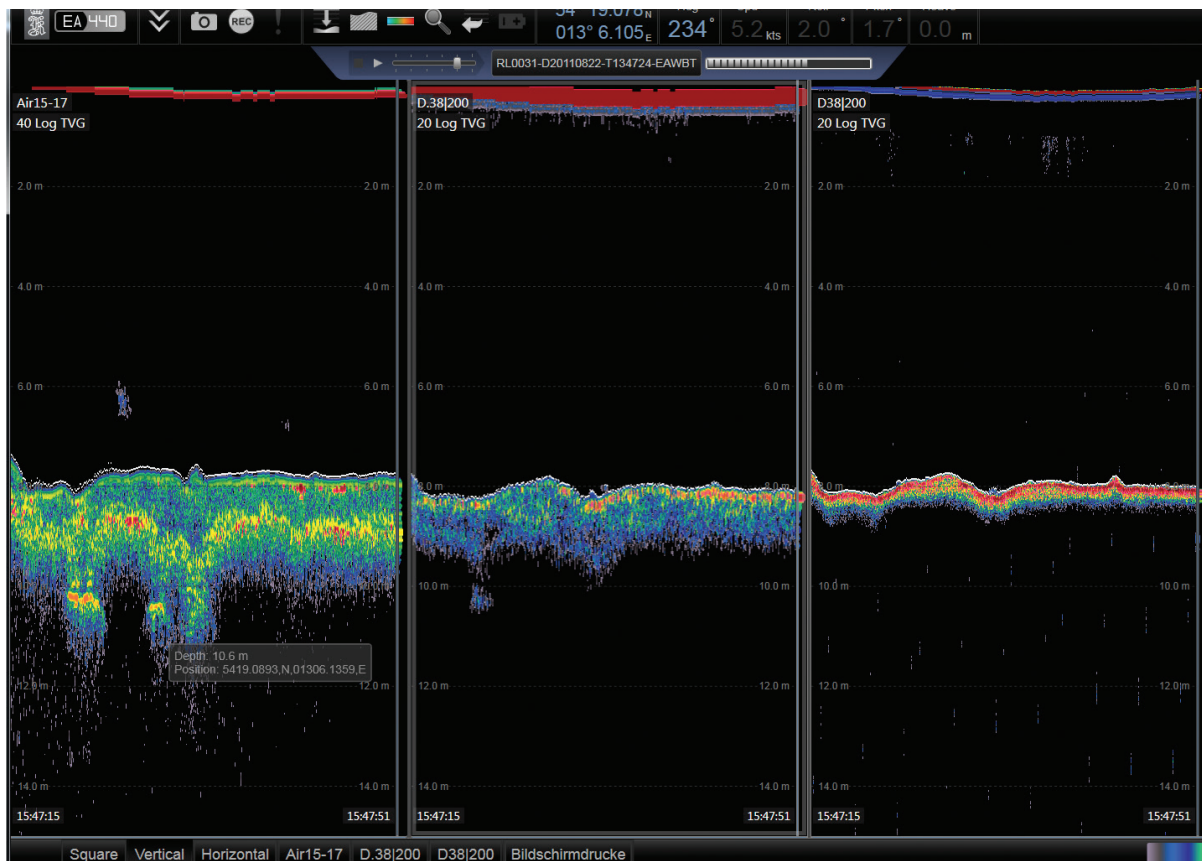
In addition to displaying vertical depth, a common option is to add two 500kHz side scan transducers and a 15kHz frequency transducer for sub-bottom profiling.

Several software packages from third party vendors can be used simultaneously.

The system can be powered from a 12 - 15V power source or from the mains.

The system can also be delivered as a portable, splash proof version - the EA440 SP.

A screen-grab of an EA440 echogram with 15kHz, CW Pulse, 2.5m sub-bottom (Düker)



Deep water applications

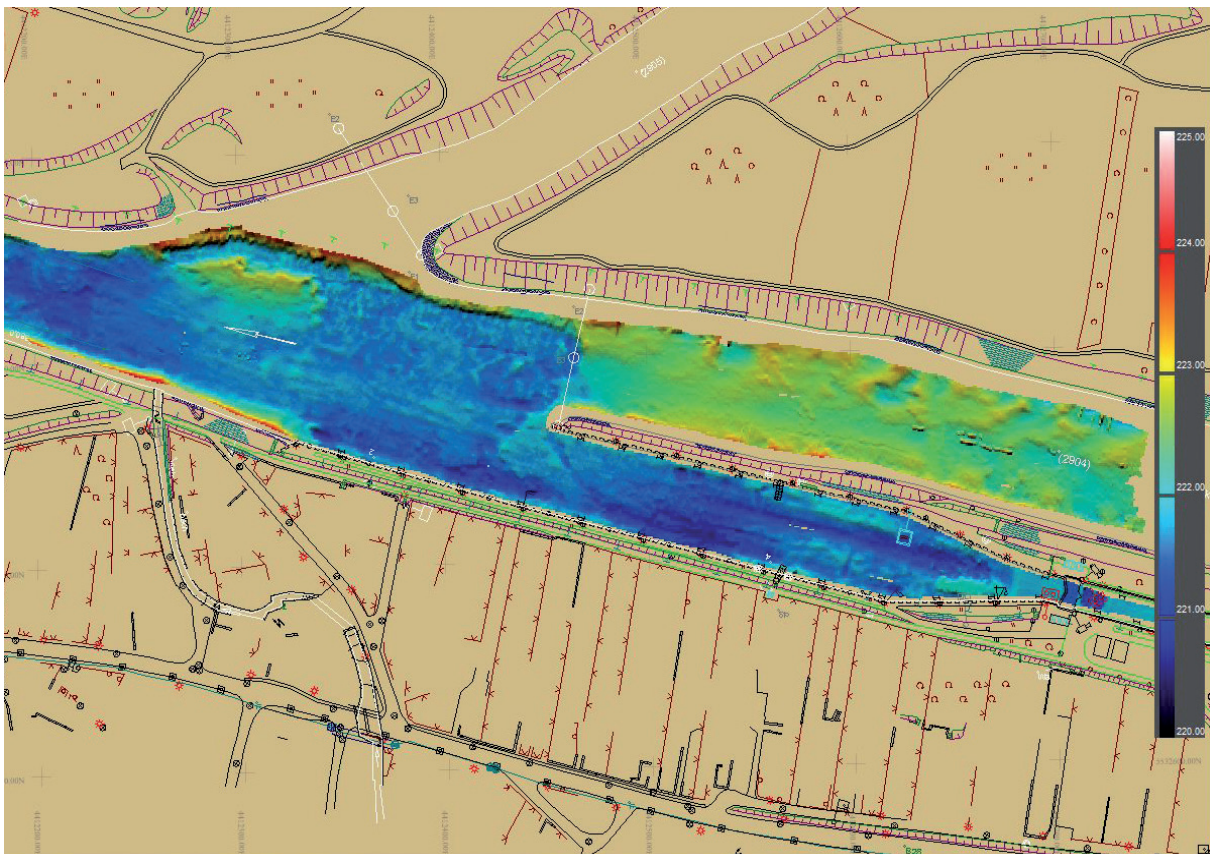
The EA600 is the standard system for research, seismic and other vessels requiring full ocean depth capability. It is easy to install and it supports up to four channels. Each channel can be selected among a preset list of frequencies, ranging from 10 kHz to 710 kHz. In deep water application the EA 600 can send multiple pulses at the same time to maintain a high ping rate. The system also have a pinger mode for accurate depth tracking of acoustic pingers.

Multi channel systems

The EA MCU is a hydrographic sweep system specifically designed for use in channels, rivers and other shallow bodies of water. Its precise depth and bottom detection capabilities provide consistent and accurate data over an entire sweep.

The system readily detects obstacles and objects on the bottom. Its very high ping rate ensures that it finds very small objects, even when they are covered by sediments. Both the depth and bottom profile can be monitored simultaneously using a standard echogram and a waterfall display. The system comes with a user friendly topside software.

Digital Terrain Model (DTM) created with datasets from an EA MCU hydrographic sweep system. The resulting grid shows a detailed bottom morphology of the navigational channel.



INTEGRATED SOLUTIONS

Kongsberg Maritime has an incomparable history delivering large integrated packages for specialised applications. We are known worldwide for our subsea solutions that provide THE FULL PICTURE.

We have been involved in state of the art work on many vessels, and we have been commissioned not only to configure our own systems but also third party equipment. This integrator role is one of our biggest strengths.

Amongst the many benefits of using Kongsberg Maritime to provide integrated solutions are that we provide a single source for equipment, a single point of contact and a single source of responsibility. Planning is easier, logistics more manageable and delivery more streamlined when you have THE FULL PICTURE.

INFORMATION MANAGEMENT

AUTOMATION AND POWER MANAGEMENT

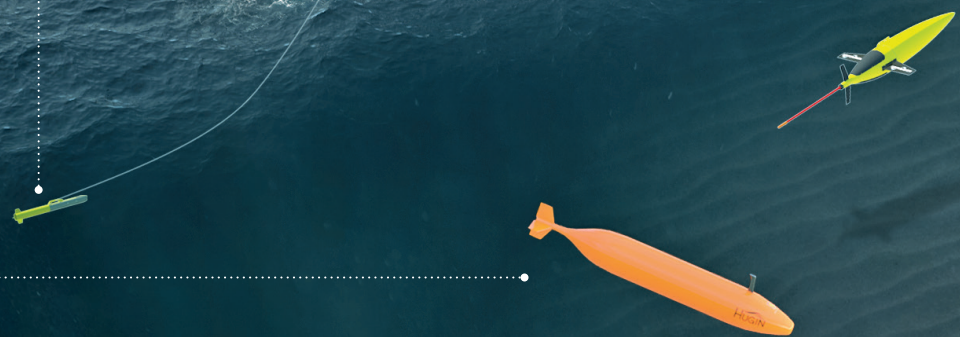
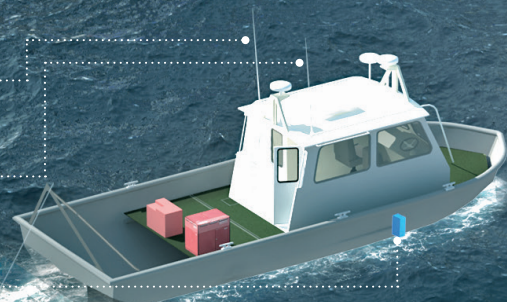
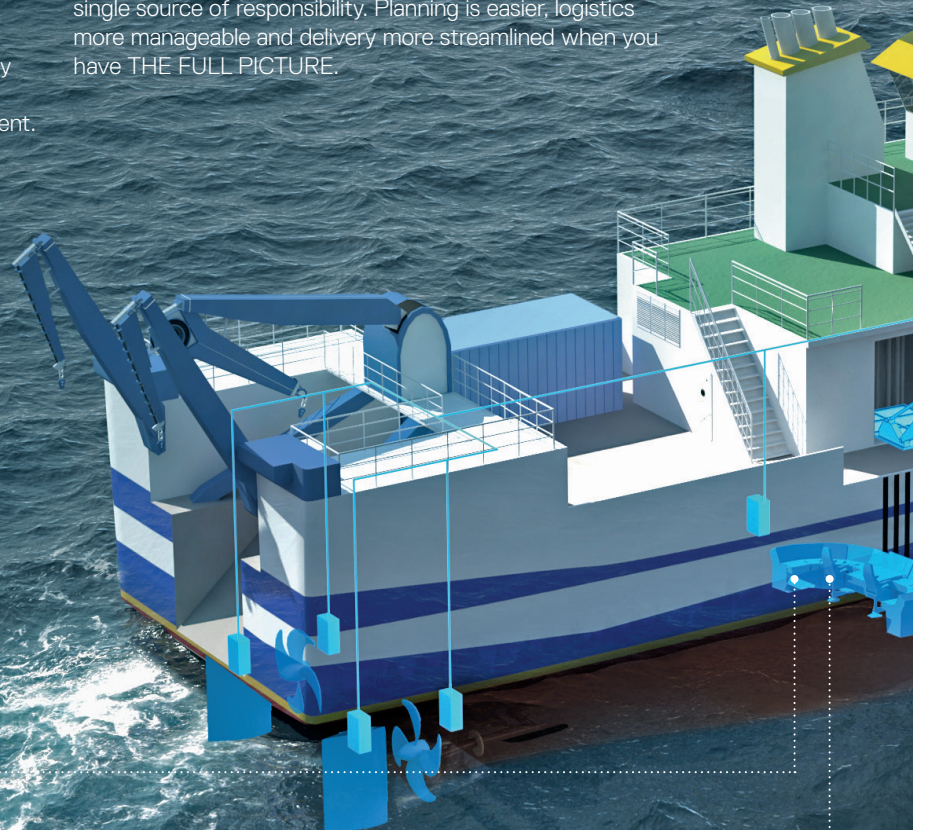
POSITION REFERENCE SYSTEMS

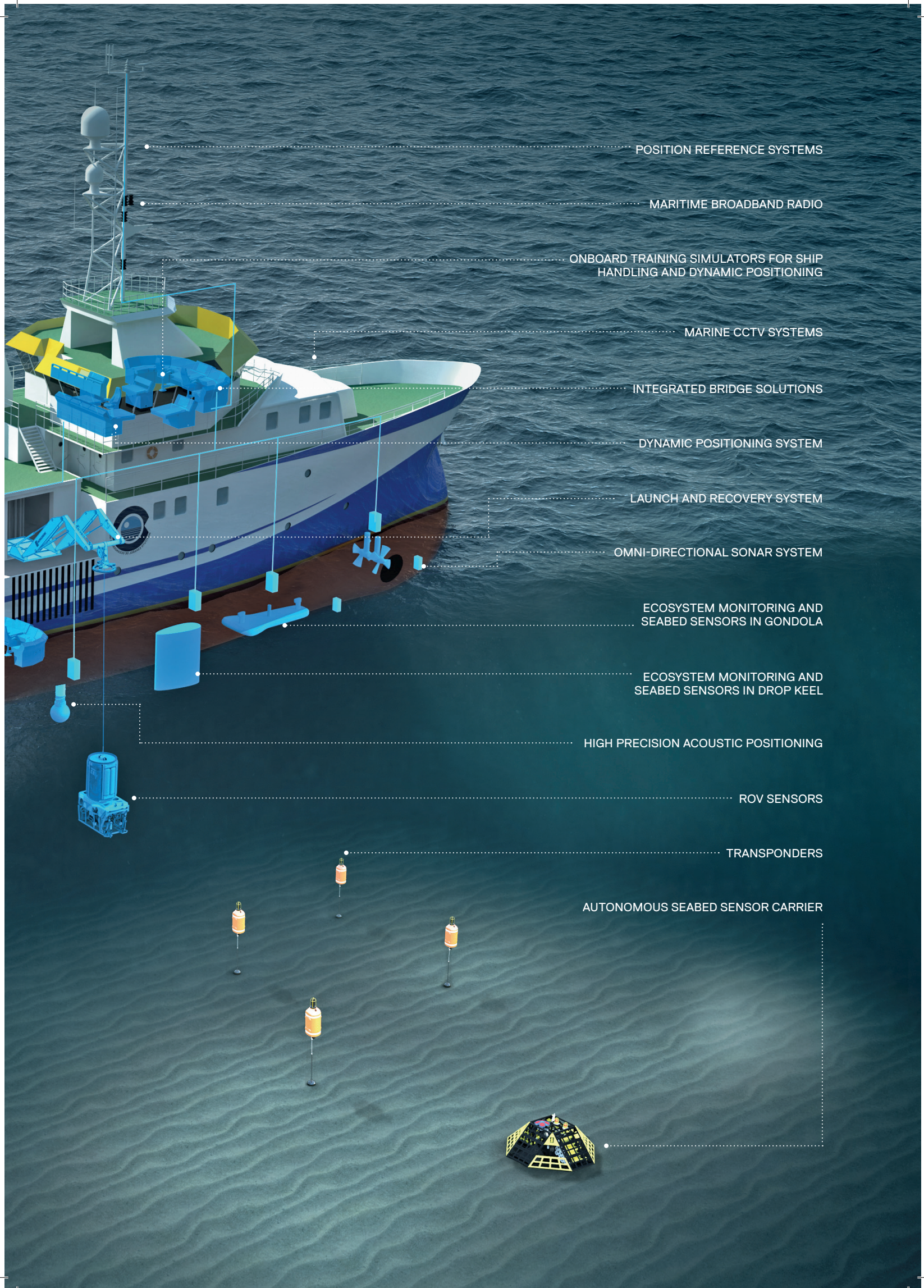
MARITIME BROADBAND RADIO

ECOSYSTEM MONITORING
AND SEABED SENSORS

SIDE SCAN SONAR

MARINE ROBOTICS





POSITION REFERENCE SYSTEMS

MARITIME BROADBAND RADIO

ONBOARD TRAINING SIMULATORS FOR SHIP HANDLING AND DYNAMIC POSITIONING

MARINE CCTV SYSTEMS

INTEGRATED BRIDGE SOLUTIONS

DYNAMIC POSITIONING SYSTEM

LAUNCH AND RECOVERY SYSTEM

OMNI-DIRECTIONAL SONAR SYSTEM

ECOSYSTEM MONITORING AND SEABED SENSORS IN GONDOLA

ECOSYSTEM MONITORING AND SEABED SENSORS IN DROP KEEL

HIGH PRECISION ACOUSTIC POSITIONING

ROV SENSORS

TRANSPONDERS

AUTONOMOUS SEABED SENSOR CARRIER

TECHNICAL SPECIFICATIONS

MULTIBEAM SYSTEMS

SYSTEM	EM® 2040 SINGLE RX	EM® 2040 DUAL RX	EM® 2040C SINGLE HEAD	EM® 2040C DUAL HEAD	EM® 2040P	EM® 712	EM® 302	EM® 122	M3
OPERATING FREQUENCY (kHz)	200 - 400					40 - 100	30	12	500
DEPTH RANGE (m)	0.5 - 600		0.5 - 490		0.5 - 510	3 - 3600	10 - 7000	50 - 11000	0.2 - 50
MAX COVERAGE (gravel)	>800 m 140° 5.5 x water depth	>850 m 200° 10 x water depth	500 m 130° 4 x water depth	>550 m 200° 10 x water depth	>800m 140° 5.5 x water depth	4200 m 140° 5.5 x water depth	>8 m 143° 5.5 x water depth	>35 m 150° 6 x water depth	175 m 120° 3.5 x water depth
BEAM WIDTHS (degrees)	TX: 0.4, 0.7 RX: 0.7		TX: 1.0 RX: 1.0			TX: 0.25, 0.5, 1, 2 RX: 0.5, 1, 2	TX: 0.5, 1, 2, 4 RX: 1, 2, 4	TX: 0.5, 1, 2 RX: 1, 2, 4	TX: 3.0 RX: 1.6
SYSTEM ACCURACY (better than)	10 mm					0.2 % x water depth			10 mm
MAX NO. OF SOUNDINGS PER PING	Up to 800	Up to 1600	Up to 800	Up to 1600	Up to 800	Up to 1600	Up to 864		Up to 256
PULSE FORM	CW and FM								
EFFECTIVE PULSE LENGTH	14 µs - 12 ms					200 µs - 120 ms	700 µs - 200 ms	2 ms - 100 ms	10 µs - 10 ms
MAX PING RATE (Hz)	50					30	10	5	40
TRANSDUCER DEPTH RATING (m)	6000		50, 1500		30	250	N/A		500, 4000

WIDE SWATH SYSTEMS

SYSTEM	GeoSwath Plus 125 kHz	GeoSwath Plus 250 kHz	GeoSwath Plus 500 kHz
OPERATING FREQUENCY (kHz)	125	250	500
RANGE (m)	0.5 - 200	0.5 - 100	0.5 - 50
MAX COVERAGE (gravel)	Up to 780 m 12 x water depth	Up to 390 m 12 x water depth	Up to 195 m 12 x water depth
BEAM WIDTHS (degrees, combined TX - RX along track)	Along track 0.85	Along track 0.75	Along track 0.5
SYSTEM ACCURACY	>1 cm		
MAX NO. OF SOUNDINGS PER PING	> 5000 raw data points		
PULSE FORM	CW		
PULSE LENGTH	128 - 896 µs	64 - 448 µs	32 - 224 µs
MAX PING RATE	30 Hz		
TRANSDUCER	4000 m		

SUB BOTTOM PROFILERS

SYSTEM	TOPAS PS 18	TOPAS PS 40	TOPAS PS 120	SBP 120 / SBP 300	GeoPulse	GeoPulse Plus
OPERATING PRINCIPLE	Parametric			Linear	Linear CW	Linear CW, Chirp
FREQUENCY RANGE (kHz)	0.5 - 6	1 - 10	2 - 30	2.5 - 6.5	2 - 12	1.5 - 18
DEPTH RANGE (m)	10 - 11000	5 - 2000	2 - 400	10 - 11000	5 - 3000*	5 - 4000*
MAX VERTICAL RESOLUTION (m)	0.2	0.1	0.04	0.25	0.1	0.06
MAX PENETRATION (m) Note: dependent on substrate	200	80	50	200	80	80
INSTALLATION	Hull	Hull / over the side		Hull with EM® 122/302	Hull / over the side / towed	

*Dependent on the number of transducers in the array

SIDE SCAN SONAR

SYSTEM	EA440 side scan	PuLSAR	HiSAS 1032
OPERATING PRINCIPLE	Single beam		Synthetic Aperture
FREQUENCY RANGE (kHz)	200 & 500	600 - 1000	70 - 100
DEPLOYMENT DEPTH (m)	N/A	0 - 100	0 - 4500
ACROSS TRACK RESOLUTION (cm)	1.2	1	4 constant
ALONG TRACK RESOLUTION	0.5 degree (200kHz) 0.35 degree (500kHz)	7cm (10 m), 23cm (50 m), 69cm (100 m)	4 constant
DEPLOYMENT OPTION	Hull mounted	Towed	HUGIN® AUV payload

LIFE CYCLE SUPPORT

Designed to purpose – maintained to last

Our life cycle management service will assist our customers throughout all the phases, from design to commissioning and during the operational life time.

Solid in-house competence, both in system design and user competence enables us to provide solutions that are fit to purpose and thus yields efficiency in operation. Our common base technology provides robust designs, with few and reliable parts, an excellent foundation to maximize the output at competitive costs.

The distributed and open system design employs an industry standard communication network. Standard hardware components used for various applications and the open network approach results in:

- Increased reliability
- Competitive life-cycle support
- Easy up-grade solutions

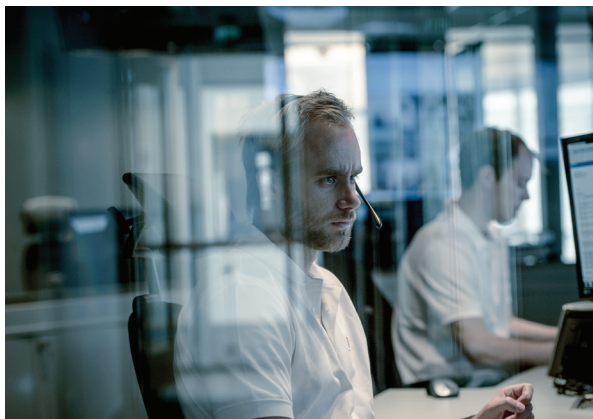
Evergreen

We offer continuous hardware and software upgrade to keep your vessel at maximum efficiency. Our system is designed with consistent boundaries between individual systems and control segments. This design strategy makes it easy to add new functionality or complete new control segments thus enable us to offer up-grades step by step to keep your system evergreen.

Training

Qualified personnel are one of your major assets in efficient and safe operations. Thus, we offer modular training courses for all major subjects – from operator training to technical training that keeps your crew fit on the job.

PLANNING & DESIGN	PROJECT ENGINEERING & DEVELOPMENT	INSTALLATION & COMMISSIONING	OPERATION & MAINTENANCE	MODERNISATION
		On-line support »		
		Technical support »		
Technical consulting »				
	Design and software engineering »			
		Field service »		
		Repairs and spare parts »		
		Optimization and modernization »		



Supported by professionals

Our systems are easy to install and maintain – supported by professionals either on-site or through remote connectivity. They are designed for optimal operational availability and allow for favourable lifecycle expenditure

GLOBAL SUPPORT 24/7

We are always there, wherever you need us. KONGSBERG customer services organisation is designed to provide high-quality, global support, whenever and wherever it is needed. We are committed to providing easy access to support and service, and to responding promptly to your needs. Support and service activities are supervised from our headquarters in Norway, with service and support centres at strategic locations around the globe – where you are and the action is.

As part of our commitment to total customer satisfaction, we offer a wide variety of services to meet individual customers' operational needs. KONGSBERG support 24 is a solution designed to give round-the-clock support. For mission-critical operations, KONGSBERG support 24 can be extended to include remote monitoring. We can adapt the level of support needs by offering service agreements, on-site spare part stocks and quick on-site response arrangements.



Global and local support

We provide global support from local service and support facilities at strategic locations world wide. Service and support work is carried out under the supervision of your personal account manager, who will ensure that you receive high-quality service and support where and when you need it.

Your account manager will ensure continuity and work closely with your personnel to improve and optimise system availability and performance.

Under the direction of your account manager, and with a local inventory of spare parts, our wellqualified field service engineers will be able to help you quickly and effectively.

SALES

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GLOBAL SUPPORT 24/7

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For more about the Underwater Mapping product range visit: km.kongsberg.com/underwatermapping

kongsberg.com



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