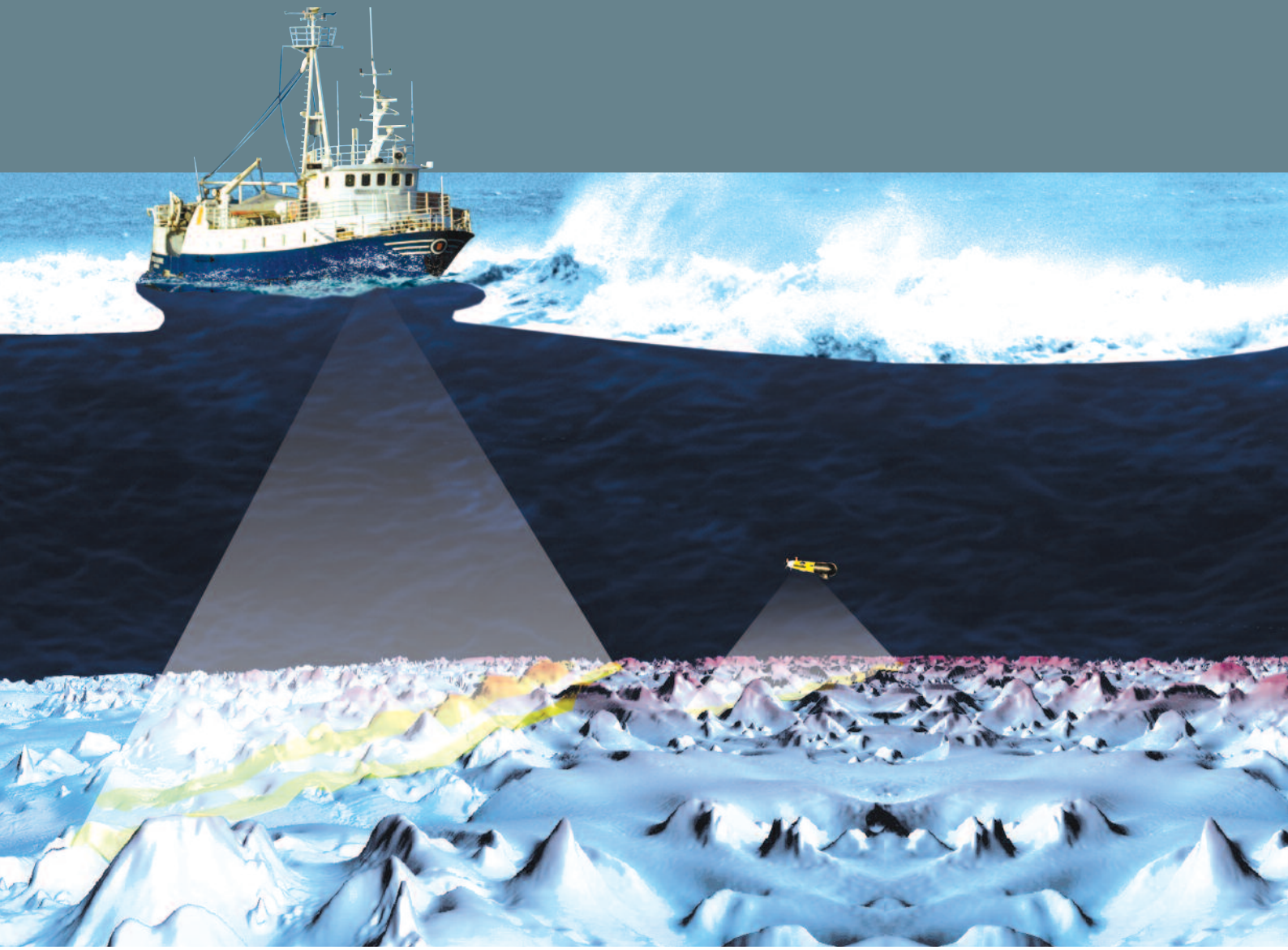
KONGSBERG

The hydrographic product family

Sound in water reveals the secrets of the deep blue



www.kongsberg.com

The Hydrography family:

Multibeam echo sounders

Wide-swath systems

Singlebeam echo sounders

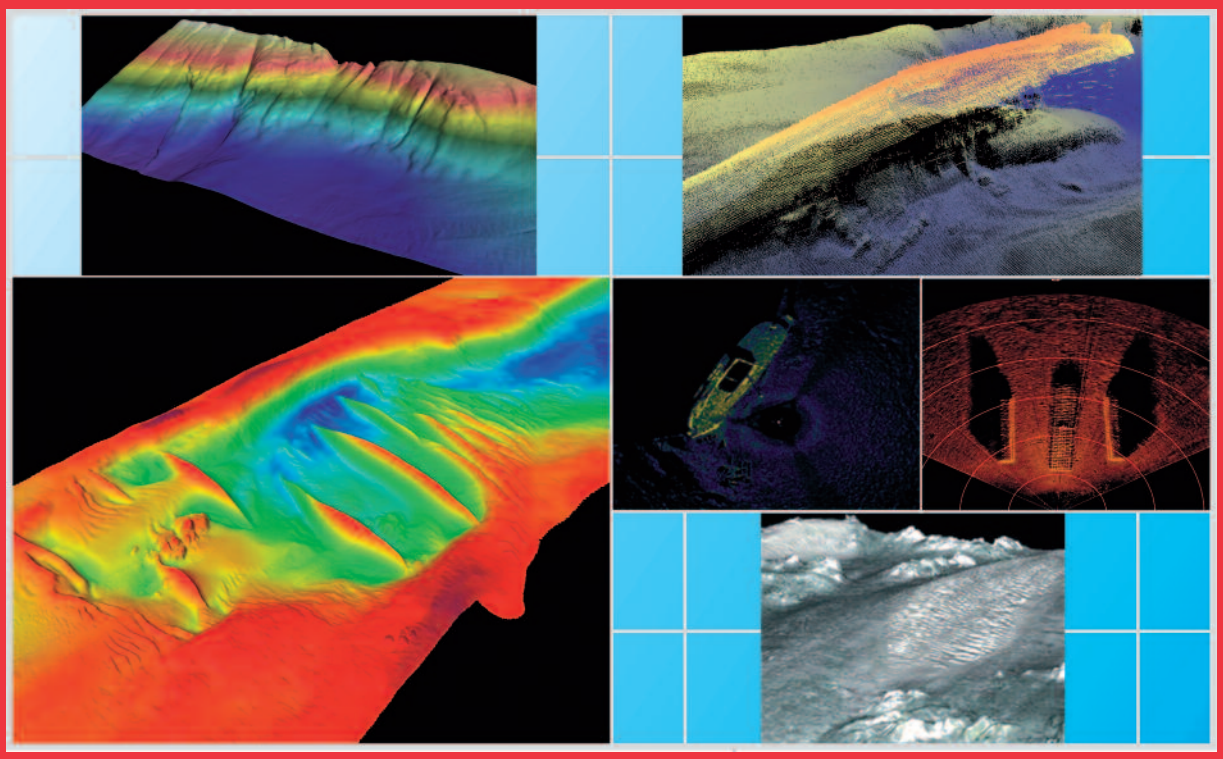
Sidescan sonars

Imaging Sonars

Sub bottom profilers

Synthetic Aperture Sonar

Integrated solutions



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 utlilising 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

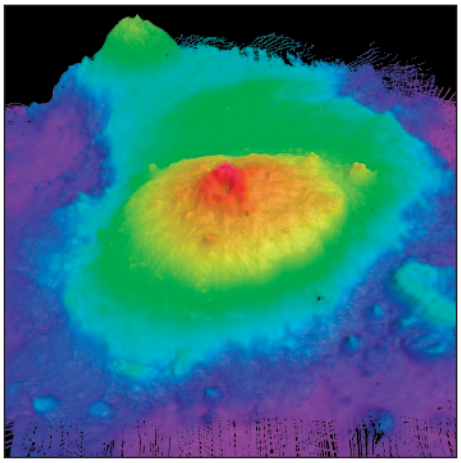
Our success depends on the success of our customers. Actively listening to our customers and truly understanding their needs, and then translating these needs into successful products and solutions is central to achieving our goal. Our people are the key to our success and we empower them to achieve.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

In the forefront of technology

Kongsberg Maritime is the major supplier of high quality marine electronics in the world, with products ranging from underwater sensor systems to complex ship and process control systems for commercial vessels and oil rigs as well as autonomous underwater vehicles, sonars and instrumentation systems for fisheries, naval and scientific research vessels. The products are designed, tested and produced to be reliable over a long time in the tough marine environment.

Hydrographic survey ships and launches



With the task of collecting accurate information about the seabed, hydrographic survey vessels must be equipped with instrumentation that is efficient, accurate, and reliable.
The Kongsberg survey instrumentation solutions are adaptable to the different user requirements, through a broad range of sonars and echo-sounders. Real time data processing and visualization software gives the surveyors immediate information about the progress of work and the quality of the data that is being collected.

Invisible sound makes everything visible

Acoustic sound transmission represents the basic techniques for underwater navigation, telemetry, echosounders and sonar technology. Common for all is the use of underwater pressure wave signals that propagate with a speed of 1500m/s through the water. When the pressure wave hits the sea bottom or another object, a reflected signal is transmitted back and detected. The reflected signal contains information characterizing the reflected object. The sea is far from an ideal transmission medium, with acoustic noise and multi-path interference as some of the major concerns. With more than fifty years in the business, we have learned to master sound in water to reveal the secrets of the deep blue.

Some images are courtesy of CHS and NOAA.

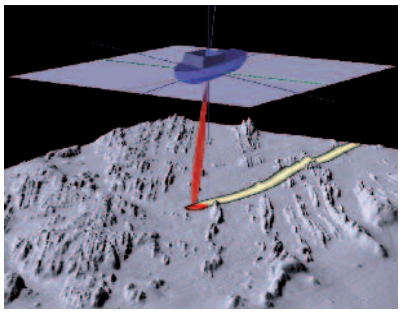
MULTIBEAM ECHO SOUNDERS

Kongsberg Maritime has been a supplier of echo sounders for more than 60 years and of multibeam echosounders since 1986 and is recognized as the world's leading supplier of Multibeam Echosounders for use in all water depths.
Since the first multibeam system KM has been recognized as a dependable supplier of multibeam systems and a respectable numbers of systems have been delivered through out the years. All systems have quickly earned reputations for being reliable and with outstanding performances.
All systems in our product range use digital techniques throughout the processing chain and have sophisticated bottom detection algorithms.

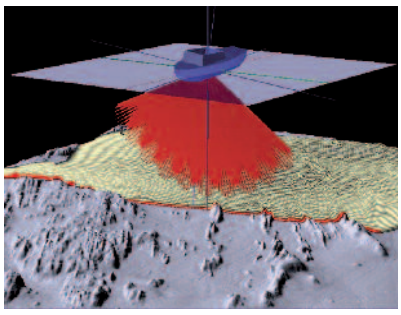
What is a multibeam system?

Multibeam echo sounders (MBES) collect bathymetric soundings in a swath perpendicular to the ship track by electronically forming a series of transmit and receive beams in the transducer hardware which measure the depth to the sea floor in discrete angular increments or sectors across the swath (Hughes-Clarke, J.E., Mayer, L.A., and Wells, D.E., 1996).

Multibeam bathymetry is based on the fact that more beams are better than one. They map the seafloor by generating several hundred beams over a crosstrack profile for each ping, and each beam generates at least one depth sounding.
While the platform sails forward the seafloor is covered with a dense pattern of soundings producing high-resolution bathymetry data and geo-referenced high resolution seabed imagery throughout the survey area and thus providing 100% coverage of the seafloor. Different models are offered for different water depth requirements and several versions of each model are available with different resolution capabilities.



Singlebeam echo sounder

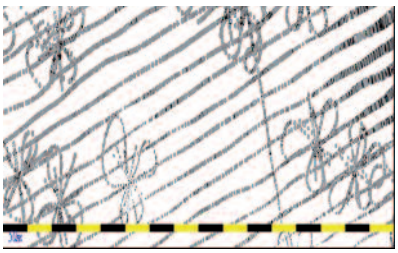


Multibeam echo sounder

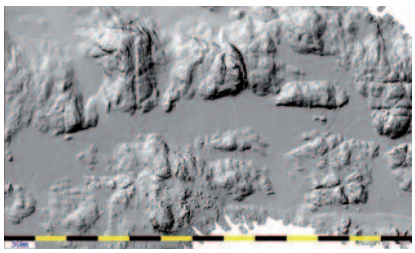
Images: ©J.E. Hughes Clarke, OMG/UNB

A typical multibeam system consist of four units, a transmit transducer, a receive transducer, a transceiver unit and an operator unit.
The transmit transducer is long in the alongship direction and short in the athwart ship direction; enable the system to generate a swath of sound which is wide in athwart ship and narrow in the alongship direction. The receiver is wide in athwart ship direction and narrow in the alongship, enabling the system to receive the wide swath produced by the transmitter, but still have narrow beams in the along track direction.

The sound generated by the transmit array, is reflected by the sea the seafloor at different angles and is received by the receiver transducer at slightly different times. All the signals are then processed by the transceiver unit, converted into depth values and plotted as a bathymetric map on the operator unit.



Singlebeam echo sounder



Multibeam echo sounder

Images: ©J.E. Hughes Clarke, OMG/UNB

Common features for all multibeam systems

Listed below are common features which are incorporated in all our multibeam systems*. Many of these features are essential to be able to ensure a dense coverage of the seafloor to fulfill requirements set by IHO S-44[1)] and LINZ[2)] even in foul weather condition.

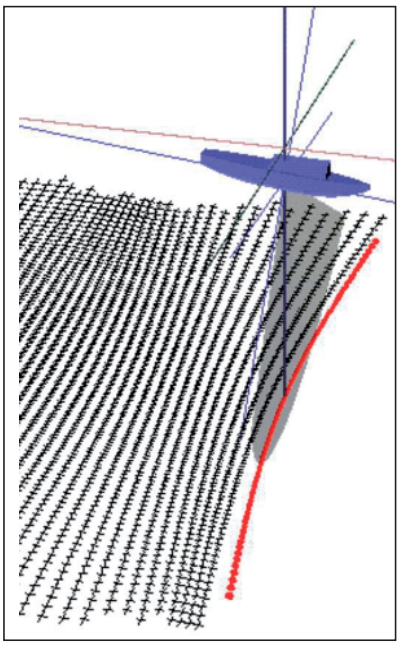
Sector transmission and stabilization

Our multibeam systems apply sound velocity correction in real time. The basic algorithm performs a ray tracing process through the water column for each beam using an 'intersection of cones' technique that is unique to the Kongsberg multibeam systems. It also computes the steered beam angles based on the surface sound speed – at the transducer. The result of this procedure will be a depth solution datagram that contains along-track, across-track, and reduced depth values for each beam.

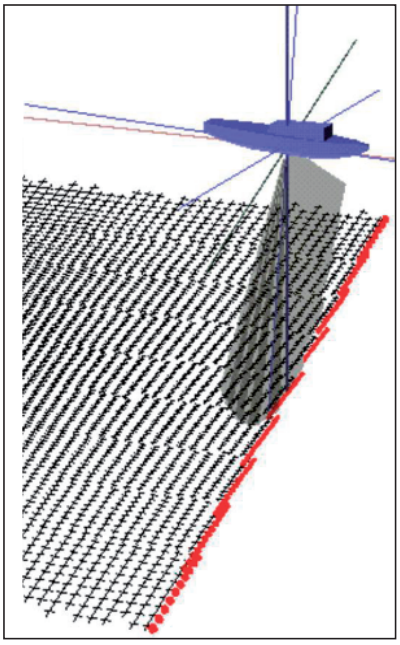
Sector transmission and stabilization

Today most systems only do compensation of the data due to vessel roll and pitch movements. It is however essential also to do stabilization to give a smooth, dense coverage of the seafloor without any gaps or holes in the data, which might lead to loss of objects or seabed features. Stabilization of the system means that both the transmitter and the receiver beams are electronically steered according to the vessels movement. In foul weather conditions the spacing between soundings as well as the acoustic footprints can be set nearly constant over the swath in order to provide a uniform and high detection and mapping performance.

Sector transmission means dividing the transmitter sector into smaller sections with different frequencies, which can be individually electronically steered.
In shallow waters the systems generate up to 4 transmit sectors, while in deeper waters up to 8 transmit sectors are being utilized (system dependent). This enables several essential key-features; such as a very effective stabilizing for pitch and yaw-movements, use of multiple focal points when focusing on transmission, increased range performance and suppression of multi-bounce signals i.e. second surface return and other multiple echoes.
Yaw and pitch stabilization are performed by tilting the different transmit sectors, while roll stabilization is done by the receiver beams.
Vessel motions will not be any problem for the systems when applying active electronic stabilization.



Without Yaw Stabilization.

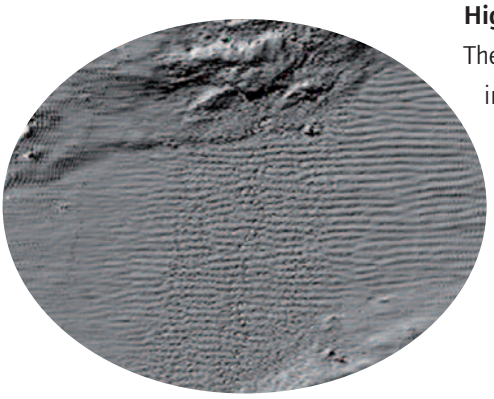


With Yaw Stabilization.

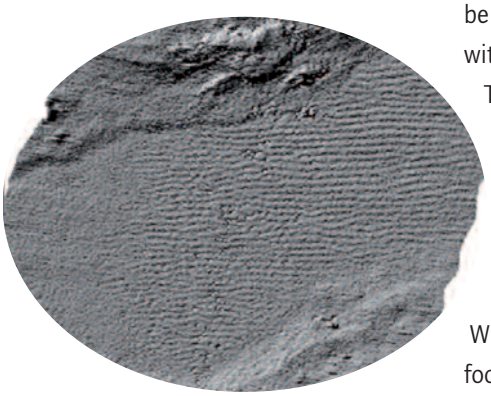
©J.E. Hughes Clarke, OMG/UNB

** Yaw stabilization and FM chirp, not available on EM 3002*

1) IHO, International Hydrographic Organization
2) LINZ, Land Information New Zealand



High density signal processing:
Standard mode - 256 soundings



High density signal processing:
High density mode - 400 soundings

Images: ©J.E. Hughes Clarke, OMG/UNB

High density signal processing and beam focusing

The horizontal resolution is much improved compared to previous models, due to the introduction of focused beams for both transmission and reception and the new high density signal processing technique.

Near-field focusing is essential for retaining angular resolution. On reception this is done dynamically (focal point is shifted as function of time/range) and on transmit each sector will have independent focal points.

Dual Swath

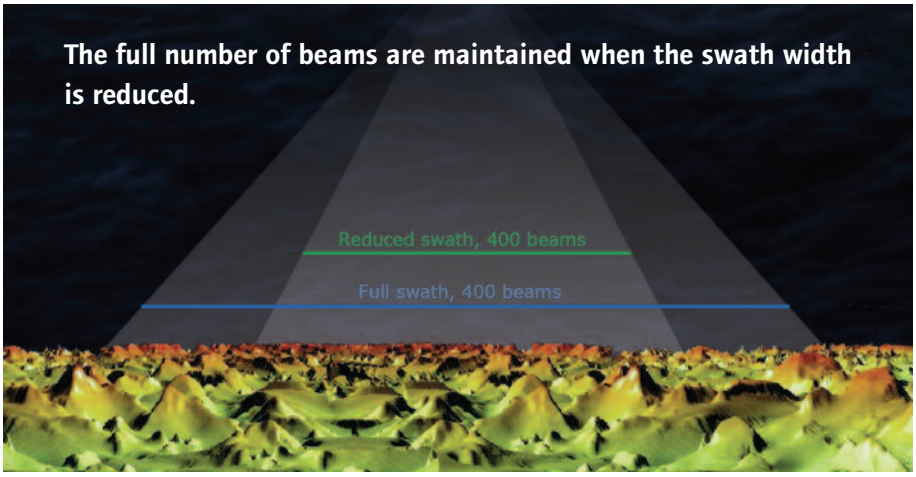
In dual swath mode the system generates two transmit swath per ping. The result will be twice the number of soundings per ping giving a denser profile of the seabed even with a very narrow transmitter or when surveying at high speed.

The main reason for using dual swath is to fulfill IHO special order requirement at ship speed of 8 knots with a 0.5 degree transmitter. Note that the dual swath is available in all configurations, enabling the survey speed to be increased and still maintaining the same dense alongship profile compared to half the speed without dual swath.

With the high density mode the crosstrack resolution is improved, by reducing the footprint size to less than 25%. This can also be seen as synthetic sharpening of the beams and is a great achievement giving a nearly constant crosstrack physical size of sounding spot over the complete swath.

Maintaining all beams in the swath

In some applications or due to weather condition the user might want to reduce the swath width. If so, the systems will not cut-off the outer beams, but will maintain all beams in the new coverage sector set by the operator. Hence, both the resolution and the ping rate will increase. This is a unique feature for all systems from Kongsberg and very useful when surveying a wreck or feature on the seabed. The operator may also select a maximum coverage to ease the line planning in sloping terrain. The system will then run in an automatic mode and maintain all beams within the selected coverage.

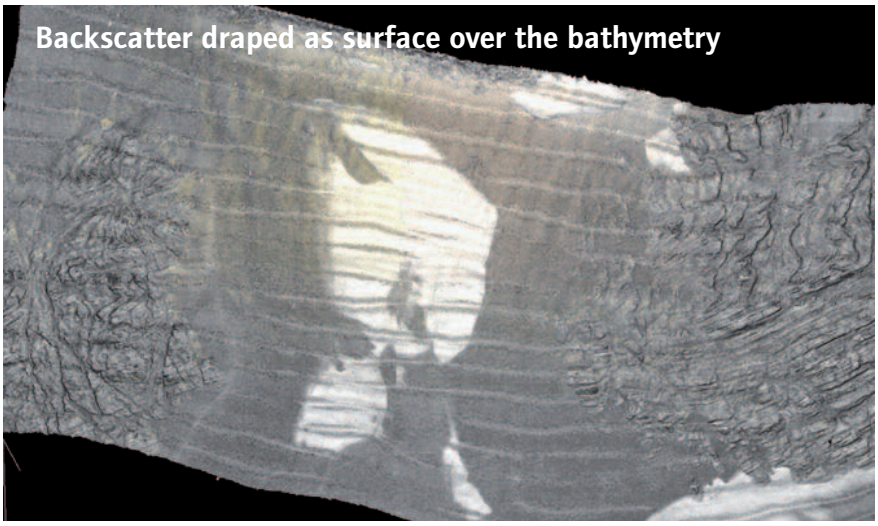


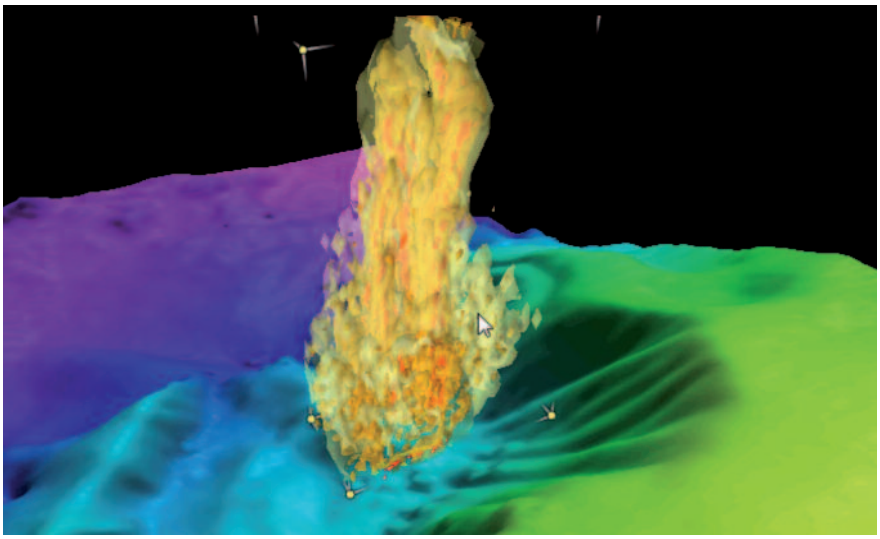
Extended coverage by use of chirp technology

The use of new frequency independent hardware makes it possible to generate other signals than continuous wave (CW) pulses, like frequency modulated chirp (FM) waveforms for extended range performance and with pulse compression on reception. The use of FM gains approximately 15dB in signal-to-noise-ratio compared to CW.

Seabed imagery and water column data

In addition to the sounding data all systems produce high resolution backscatter data and water column data. Both can be logged simultaneously with bathymetric data. Multibeam Backscatter Data is equivalent to Sidescan Imagery.



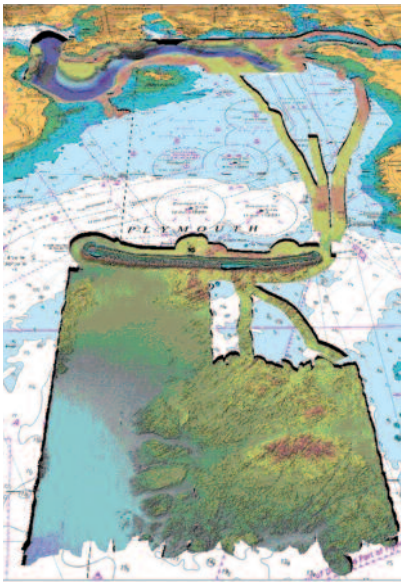


EM 302 image: Plumes located in water depths between 1200 and 1900 meters and observed to rise to about 500 meters making their heights between 700 - 1400 meters.

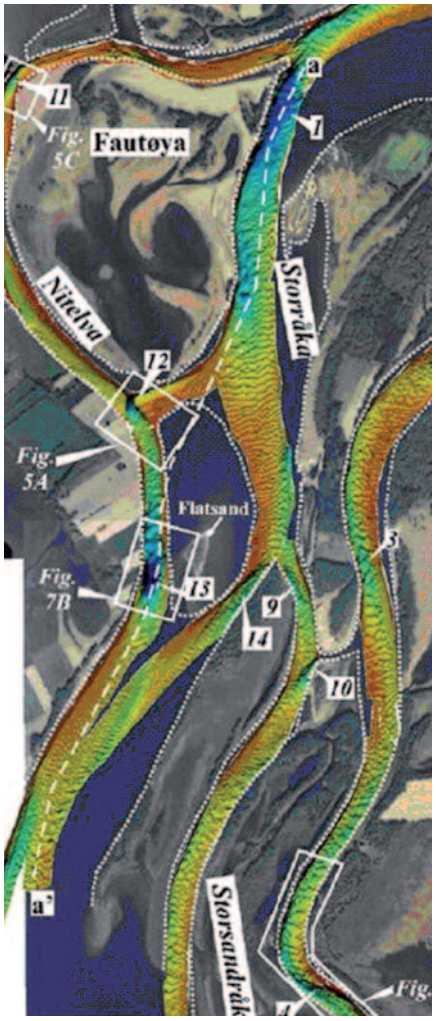
Images courtesy of NOAA Office Marine and Aviation Operations.

Functionality to limit mammal harassment

Our medium and low frequency system can be set in a flexible soft start mode as a possible means of inducing marine mammals to leave the area of high intensity sound.



GeoSwath Plus data Plymouth.
UK, data collected for nautical charting



GeoSwath Plus data
Glomma River in Norway.
Data courtesy of NGU

Wide swath bathymetry system

Kongsberg Maritime acquired GeoAcoustics in 2008. The company was already then well established and produced proven sidescan systems, sub-bottom profilers and wide swath bathymetry systems.

What is a wide swath system?
A wide swath bathymetry system is also called by several other names, "phase measuring bathymetric sonar system", "interferometric multibeam" or "bathymetric side-scan system".

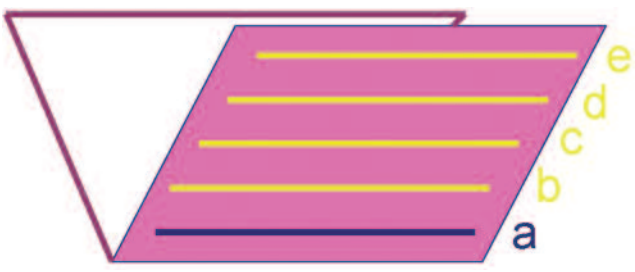
Swath bathymetry systems use two different technologies to obtain the bathymetry across the swath. A multibeam uses a beam forming technology while a wide swath system uses phase comparison techniques or interferometry. However, both systems produce the same result; a dense bathymetry map of the seafloor with additional information on backscatter strength of the seafloor.

Data from the GeoSwath Plus has been accepted as meeting strictest IHO standards, and been included in UKHO Nautical Charts.

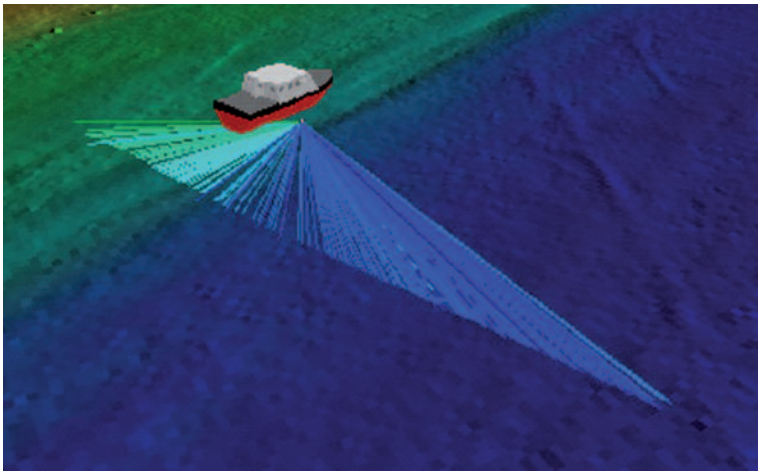
The relative phase delay between the receive staves is decoded to give the angle of return of the sonar signal and the range. Each sonar ping provides a range series of angles to the seafloor. Two questions are often raised with the phase measurement technique: the issue of simultaneous returns from two features at different angles and the lower data density under the transducers. The keys to overcoming these are the short pulse length, rapid phase measurements and very low noise electronics used in the GeoSwath Sonar.

A port and starboard ping together give the seafloor profile under the vessel and a series of pings taken as the vessel moves along the survey track gives the swath of soundings.

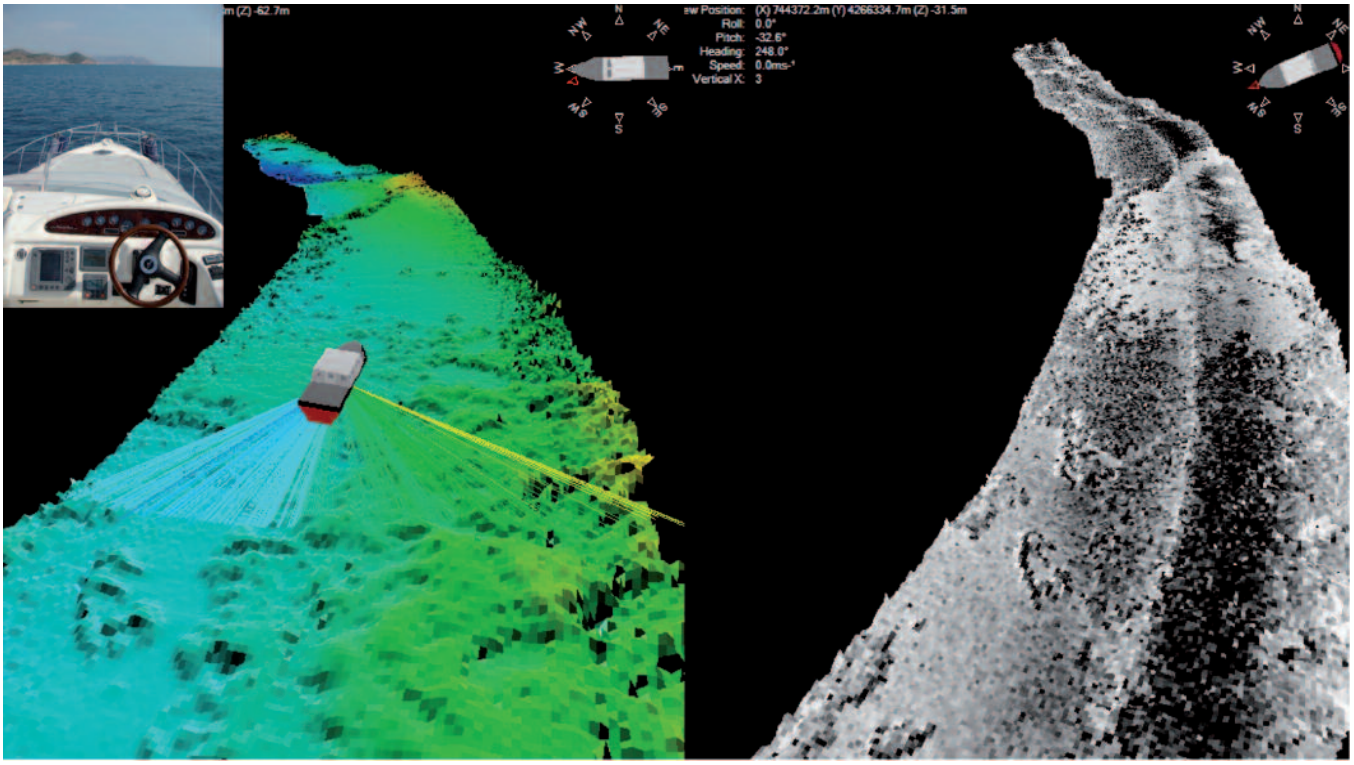
Multi-element receive array measuring phase differences. In the GeoSwath Plus case the primary array consists of two transducers mounted to a "V" plate. Each transducer contains multiple ceramic staves:



Bottom stave is transmitter, multiple receive elements.



Phase measuring systems are very productive in the shallow water environment, where they cover a wide area with a single swath and simultaneously acquire true geo-referenced side scan data.



GeoSwath Plus data 3D view – Simultaneous acquisition of wide swath bathymetry and geo-referenced side scan data.

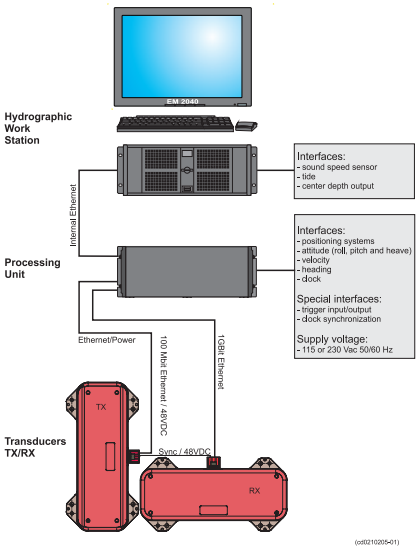
SYSTEMS FOR ALL SURVEY APPLICATIONS

For shallow water surveys, inspection, ROV and AUV applications

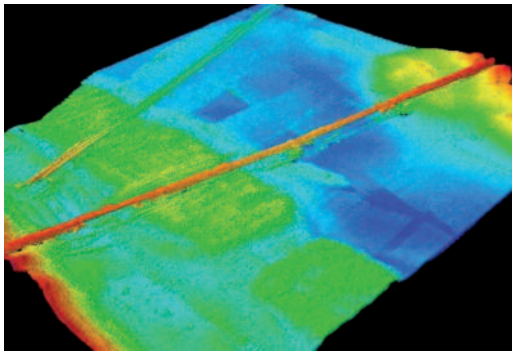
Good knowledge of shallow water bathymetry is vital to a wide range of marine activities. Surveys for navigation channels, ports and harbors, lake and dam management, environmental mapping, marine archaeology, marine construction, cable landfalls and hydrodynamic modeling all rely on accurate and detailed information on the water depth.

Such surveys are mainly in waters less than 50m deep, with many in the zone from 20m water depth to the shoreline.
High resolution, complete coverage, high accuracy, and detection of all significant features are particularly important in these circumstances.
Recently published survey specifications emphasize these points, and pay particular attention to the shallow water.
Examples of this includes the International Hydrographic Organization (IHO) Special Publication S-44 Edition 5, the LINZ specification and the United States Army Core of Engineers (USACE) Hydrographic Surveying Standards.

A sonar system for shallow water surveys must also be able to operate on shallow draft vessels, be easy to deploy and use, and reduce the time to produce a deliverable chart.



EM 2040 – From shallow to very high resolution inspection surveys
The EM 2040 is the latest generation of multibeam models and is developed to give the user the outmost performance through a very high resolution and a flexible design. It has been developed to meet the strictest requirements in the survey industry and is a true "all-in-one" tool with its wideband operation. The bandwidth used by the system is more than 75kHz with three sectors. With dual swath six sectors are used.
The system is the ideal tool for any operation from shallow water surveys to very high resolution inspections, onboard survey launches or any vessels of opportunities, hull or over the bow installation to ROV and AUV applications.
The system has an operating range from 0.5 to 600m relative to the transducer with a maximum swath width of 750m or 140 degrees for a single system. A dual system will have a coverage of up to 800m or 200 degrees, which is 10 times the water depth.

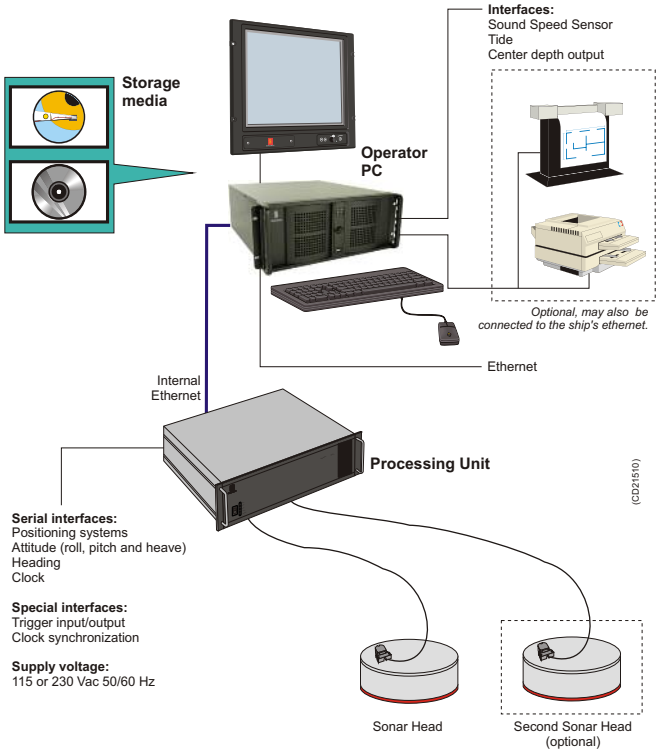


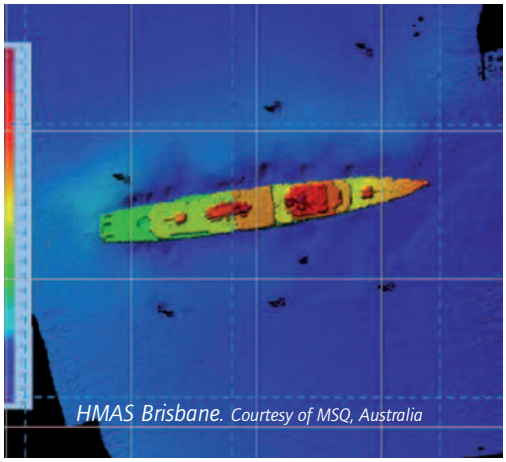
The system can be delivered with different transducer sizes for different resolutions.
A single system consists of one transmitter and one receiver, while a dual system consist of one transmitter and two receivers.
The transducers are depth rated to 6000m as standard.

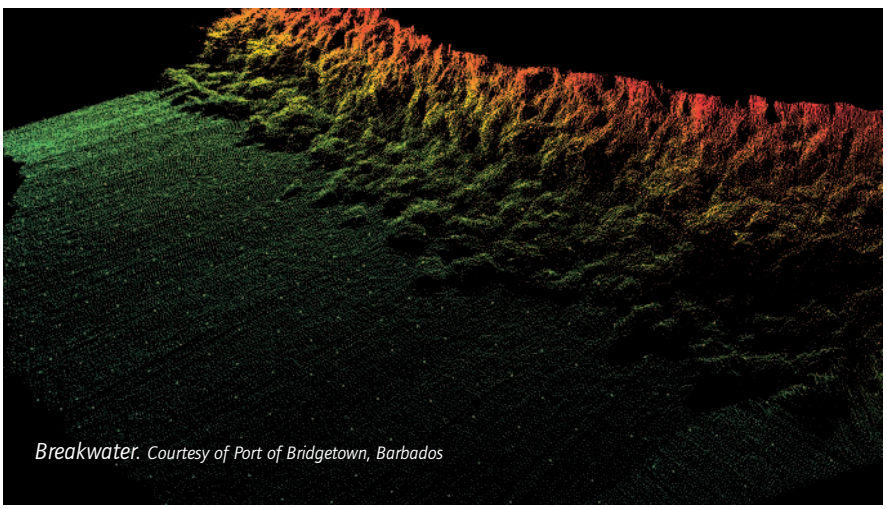
EM 2040C – From shallow to high resolution surveys

The EM 2040 Compact is a shallow water multibeam echo sounder based on the EM 2040 technology, an ideal tool for any high resolution mapping and inspection application. The receiver and transmitter are integrated in a common Sonar Head, with the same dimensions as the EM 3002. The system fulfils and even surpasses the IHO-S44 special order and the more stringent LINZ specification.

The operating frequency range is from 200 to 400 kHz with frequency selection in step of 10 kHz, enabling the user to choose on the fly the best operating frequency for the application. By utilizing both CW and FM chirp pulses, the system can achieve a much longer range capability with a high resolution. The maximum depth range is 490 m at 200 kHz with a swath with up to 625 m with Dual Head.




HMAS Brisbane. Courtesy of MSQ, Australia


Breakwater. Courtesy of Port of Bridgetown, Barbados

GeoSwath Plus – For shallow surveys with wide swath requirements

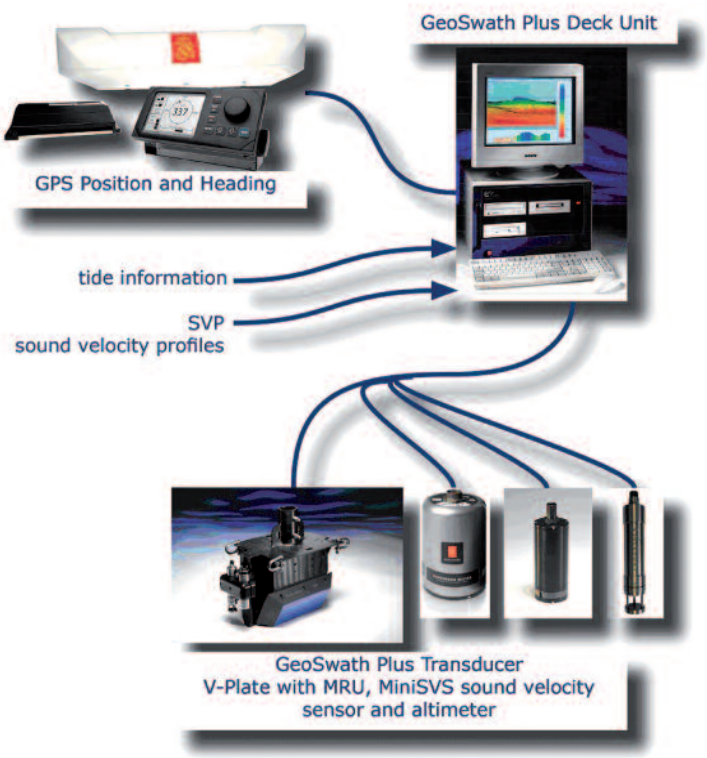
GeoAcoustics GeoSwath Plus is the market leader in the phase measuring bathymetric sonar technology and is a well proven system.

The system simultaneously acquires swath bathymetry and true side scan data with a swath coverage of up to 12 times the water depth. This makes the GeoSwath Plus a very productive survey tool for the shallow water environment producing bathymetry data shown to match IHO S-44 special order accuracy.

Three different frequency versions are available, 125, 250 and 500kHz with depth performances of 200, 100 and 50m respectively to match the survey requirements.

The system can be deployed on dedicated survey vessels as well as vessels of opportunity in versatile over-the-side, bow, moon pool or hull mount arrangements.

The standard system comprises the rugged but light weight sonar head and a dedicated deck unit including a PC running the GeoSwath Plus software package that offers all features from data acquisition to the production of the final bathymetry and side scan data products. Alternatively interfaces to all major hydrographic survey software suites are available.

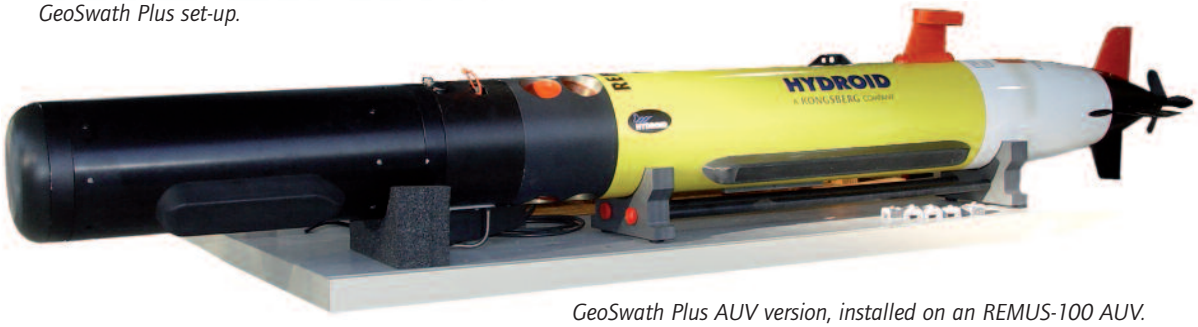


GeoSwath Plus set-up.

A compact version, GeoSwath Plus Compact, has been designed for small boat or even jet-ski operations.

The deck unit components are housed in a rugged splash proof box that links to a laptop computer from which the system is operated. It uses 24 V power and only draws 40 W.

Payload modules of the GeoSwath Plus with depth ratings of up to 4000m are readily integrated into any AUV or ROV. With data coverage of up to 12 times the vehicle's fly height and its low power consumption it offers survey efficiency for all military and civil survey applications.



GeoSwath Plus AUV version, installed on an REMUS-100 AUV.

Medium to deep water applications

EM 710 – for medium water depths

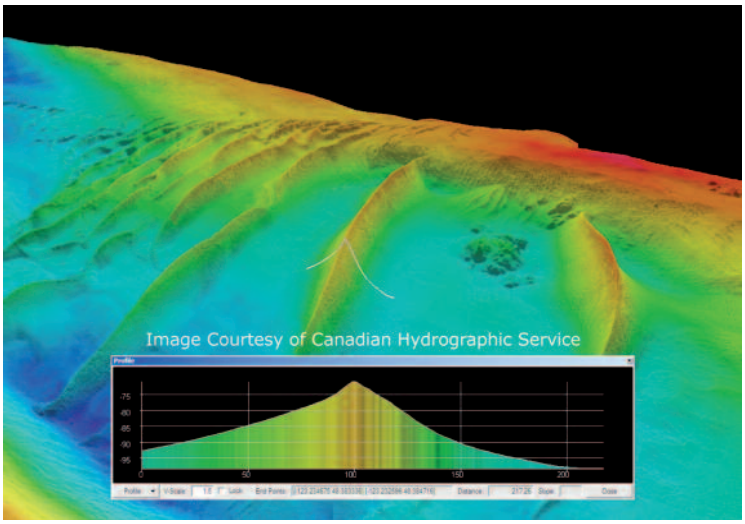
The EM 710 is a well proven and flexible multibeam for high resolution surveys from shallow to medium water depths. The operating range is from 2m to more than 2000m, with a maximum swath width of 2000m. It comes with a choice of different beamwidths, and several versions are offered with different range performances.

The EM 710 is well suited for surveys requiring performance according to IHO S-44 special order and order 1. The versions with the highest resolution are suited for detection of objects on the seafloor according to the LINZ and IHO special order requirements.

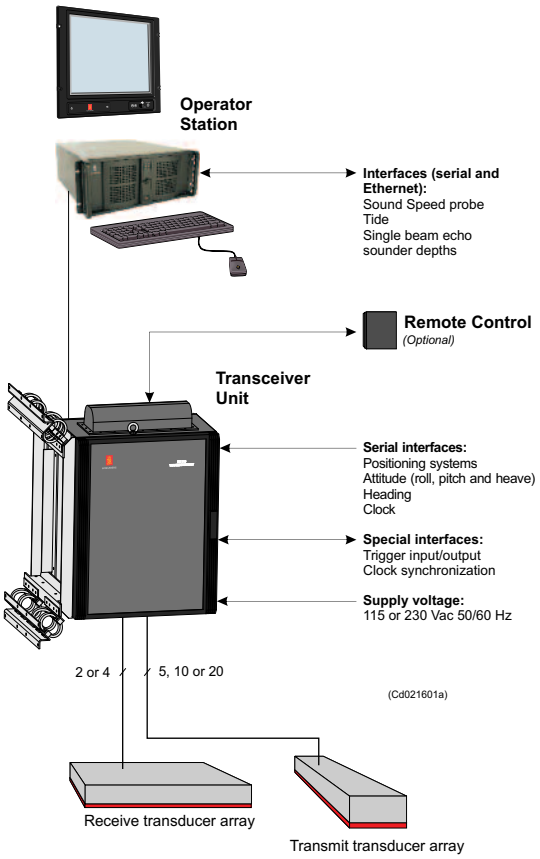
All features like stabilization for pitch, roll and yaw, but also high density signal processing and equidistant pattern are necessary for reliable object detection, and thus a standard for all systems.

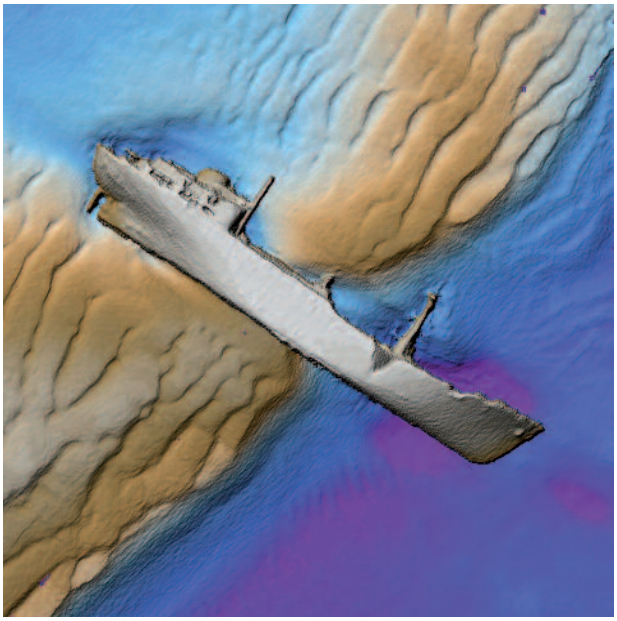
A portable model is available for the 2x2 degrees option with a smaller transceiver cabinet.

Ice reinforced versions of the transducers are available for operation in ice conditions.



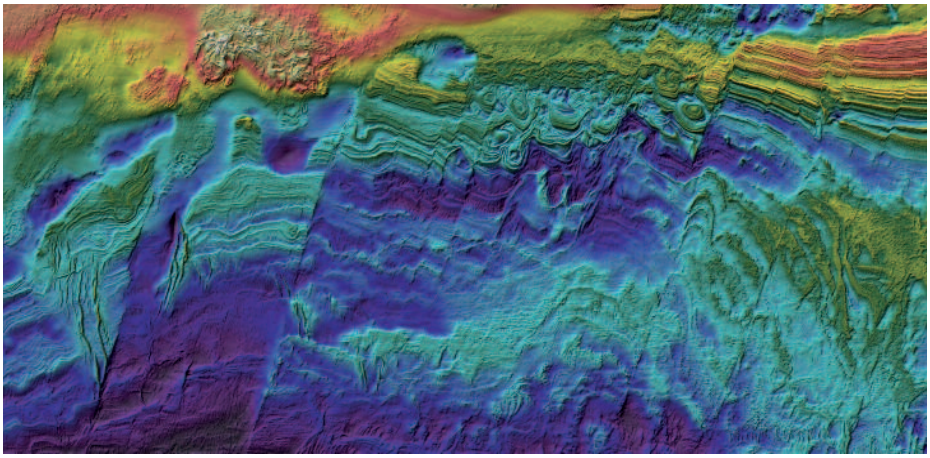
EM 710 sandwaves at Trial Island (Vancouver Island, British Columbia, Canada)





EM 710 image of MV Hoegh Aigrette at 25-42m depth.

Courtesy of UK Maritime and Coastguard Agency. Data acquisition, processing and visualisation by Fugro OSAE.

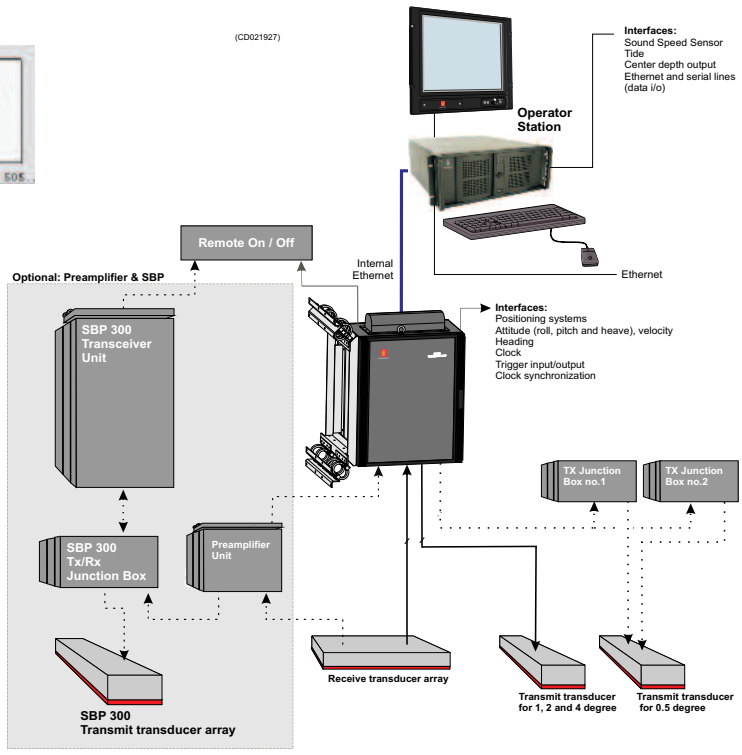


EM 710 image of Portland-Weymouth Bay 8-40m depth, 4 x 8 km area.
Courtesy of UK Maritime and Coastguard Agency. Data acquisition, processing and visualisation by Fugro OSAE.

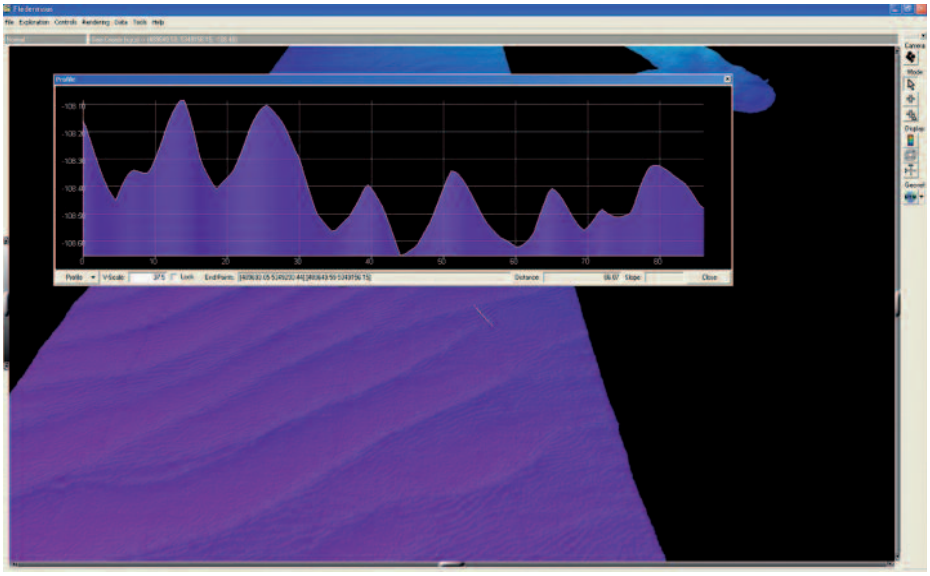
EM 302 – ocean basins

The EM 302 is a well proven multibeam for surveys starting at depths of 10m to beyond the continental rises, including the shallower ocean basins, down to 7000m. The maximum achievable swath width is about 8km. Small transducers and compact electronics makes the installation easy and the system accuracy is well within the IHO standards. The system is offered with different array sizes and beam widths.
To protect the transducers a special ice-window can be delivered. The ice-window is withstanding a pressure of 26 tons per 10 x 10 inches, and is delivered with a certificate. The system can be easily integrated with a sub-bottom profiler, the SBP 300, by adding an extra transmit transducer.

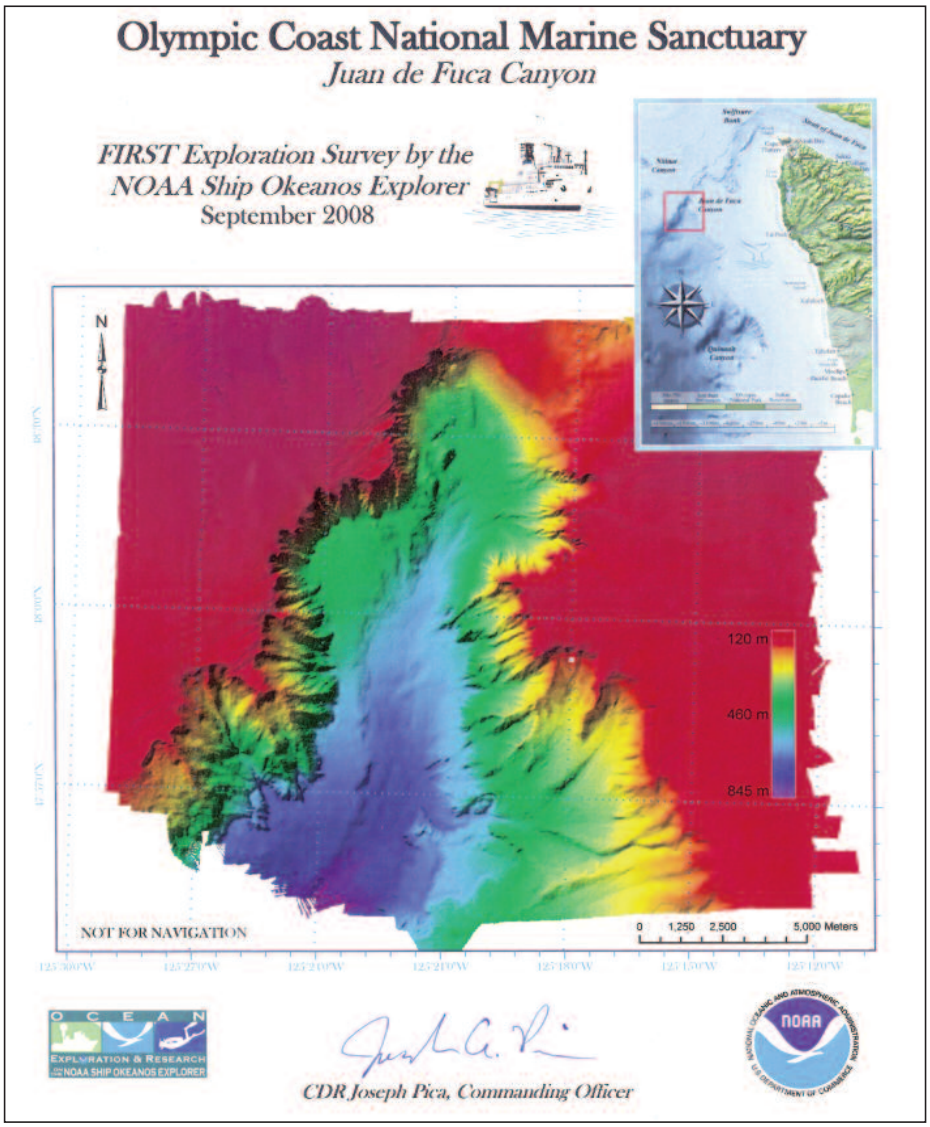
EM 302 – Swath coverage at 6553m



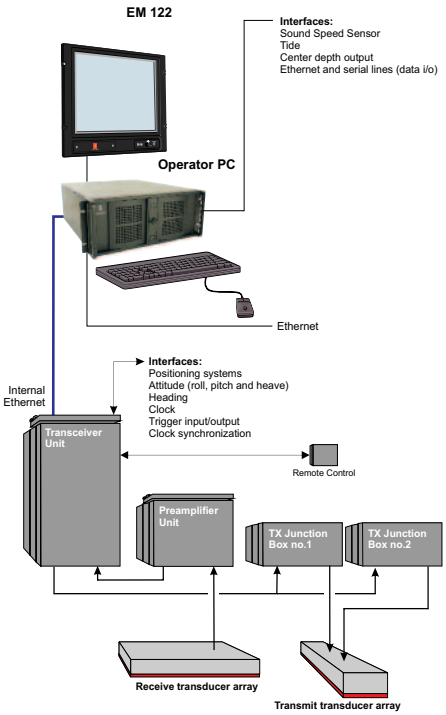
EM 302 system layout



EM 302 bathymetry differentiated sand ripples as small as 15-30cm in 100m of water.
Data Courtesy of NOAA, Okeanos Explorer.



EM 302 survey by Okeanos Explorer, depth range 120-845m.
Data Courtesy of NOAA.

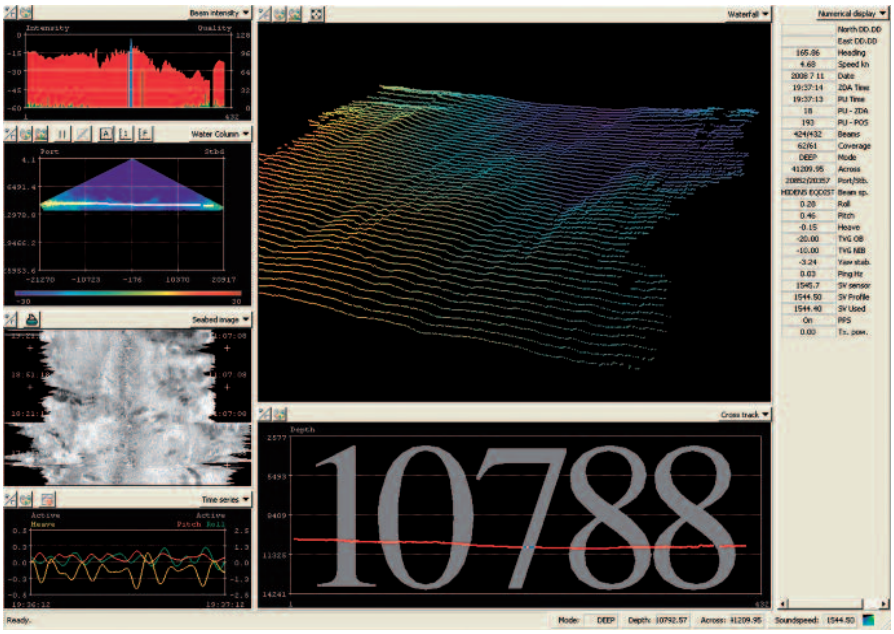


EM 122 system layout

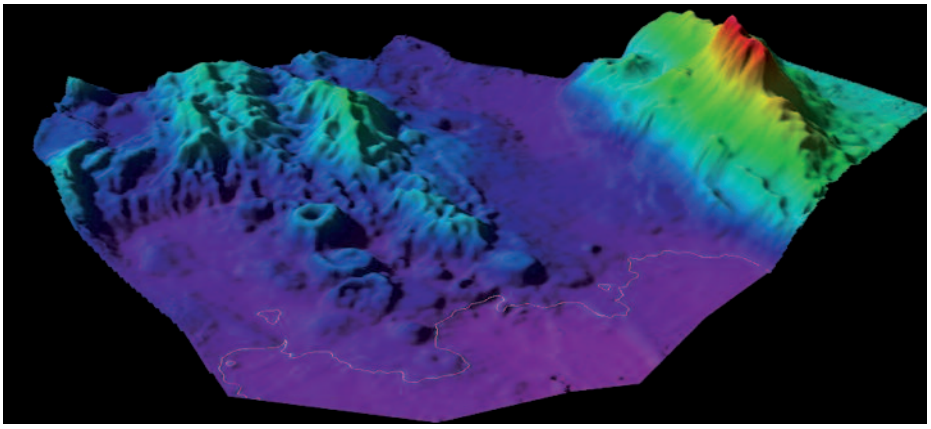
EM 122 – full ocean depth

The EM 122 is a well proven multibeam for full ocean depth surveys, suited for detailed seafloor mapping from less than 50 meters up to 11000 in the ocean. Up to 30-35km swath width is achievable and from customer acceptance tests it has been proven that the system can achieve coverage of more than 40 km under favorable conditions. The system accuracy is well within the IHO standards.

To protect the transducers a special ice-window can be delivered. The ice-window is withstanding a pressure of 26 tons per 10 x 10 inches, and is delivered with a certificate. The system can be easily integrated with a sub-bottom profiler, the SBP 120, by adding an extra transmit transducer.



EM 122 swath coverage at 10788m water depth.
Data courtesy of U.S. Naval Oceanographic Office (NAVOCEANO).



EM 122 survey of the Gakkel Ridge by the Swedish Icebreaker ODEN, depth 4000m.
Data courtesy of Stockholm University.

Technical specifications for multibeam systems

System	**EM 2040**	**EM 2040 with Dual RX**	**EM 2040C Single head**	**EM 2040C Dual head**	**EM 710**	**EM 302**	**EM 122**
Operating frequency (kHz)	200 to 400	200 to 400	200 to 400	200 to 400	70 to 100	30	12
Range (m)	0.5 to 500	0.5 to 600	0.5 to 500	0.5 to 500	3 to 2000	10 to 7000	50 to 11000
Maximum coverage (cold sea, gravel)	>700m 140dg 5.5x water depth	>800m 200 dg 10x water depth	500m 130 dg 4x water depth	>550m 200 dg 10x water depth	2500m 140 dg 5.5x water depth	>8km 150dg 5.5x water depth	>30km 150dg 6x water depth
Beamwidths (degrees)	TX:0.5, 1 RX: 1 (at 300kHz)	TX:0.5, 1 RX: 1 (at 300kHz)	TX: 1.0 RX: 1.0	TX: 1.0 RX: 1.0	TX: 0.5, 1, 2 RX: 1, 2 (at 100kHz)	TX: 0.5, 1, 2, 4 RX: 1, 2, 4	TX: 0.5, 1, 2 RX: 1, 2, 4
System accuracy	>1cm	>1cm	>1cm	>1cm	0.2 % x water depth	0.2 % x water depth	0.2 % x water depth
Maximum number of soundings per ping	Up to 800	Up to 1600	Up to 1600	Up to 1600	Up to 800	Up to 864	Up to 864
Pulse form	CW & FM	CW & FM	CW & FM	CW & FM	CW & FM	CW & FM	CW & FM
Pulse length	25us-12ms	25us-12ms	25us-12ms	25us-12ms	150us-120ms	0.7ms - 200ms	2ms - 100ms
Max pingrate (Hz)	50	50	50	50	>30	>10	>5
Transducer depth rating	6000m	6000m	50m, 1500m	50m, 1500m	250m	NA	NA
Ice protection	N/A	N/A	N/A	N/A	Yes	Yes	Yes

Technical specifications for wide swath systems

System	**GeoSwath Plus 125kHz**	**GeoSwath Plus 250kHz**	**GeoSwath Plus 500kHz**
Operating frequency (kHz)	125kHz	250kHz	500kHz
Range (m)	0-200 m	0-100 m	0-50 m
Maximum coverage (cold sea, gravel)	12x water depth Up to 780m	12x water depth Up to 390m	12x water depth Up to 195m
Beamwidths (degrees)	Along track 0.85°	Along track 0.75°	Along track 0.5°
Maximum number of soundings per ping	> 5000 raw data points	> 5000 raw data points	> 5000 raw data points
Pulse form	CW	CW	CW
Pulse length	128 to 896 µs	64 to 448 µs	32 to 224 µs
Max ping rate (Hz)	30	30	30
Transducer depth rating	4000m	4000m	4000 m

SINGLE BEAM ECHO SOUNDERS

Kongsberg Maritime has produced single beam echo sounder systems since 1957 with the first hydrographic single beam system in 1981, named EA 200.
Our hydrographic single beam echo sounders are available as single or up to 4 acoustic frequencies and can be adapted to many different applications.

What is a single beam system?
A single beam echosounders uses one common transducer for transmitting a pulse and for receiving of the returning echo. The sounder will ensonify a small area underneath the boat in one single beam. The time different between the transmit sound and its echo is used to calculate the water depth beneath the boat.

EA series
The EA series of single beam echosounder are one of the most comprehensive and high performance hydrographic single beam echo sounders available in the marked today, with a very easy and user friendly operating software. All our single beam echo sounders use Microsoft Windows™ based operating software. A comprehensive operator manual is available as online help, always there when you need it. All echo data can be stored as files: bitmap, sample data (for replay), depth data or sidescan data.

EA 400 – for shallow water applications
The EA 400 consists of a transducer, a General Purpose Transceiver (GPT) unit and a laptop. The system works with upto four simultaneous frequencies in the range of 33–710kHz. All channels are independently controlled, but with simultaneous transmission. In addition to raw data storage the system can store bitmap data, depth, position, heave and annotations. The raw data can be replayed later for generation of addition data.
The GPT has a 160dB dynamic range with a non-saturating receiver, allowing the TVG to be applied in software.
In addition to displaying the vertical depth a common option is to add two sidescan transducers for high resolution sidescan. In addition a low frequency transducer can be used for sub-bottom profiling (15kHz).
Several software packages from 3rd party vendors can be used simultaneous for displaying electronic navigational charts.

EA 400SP – portable and splash-proof system for shallow water

The EA 400SP is a portable and splash-proof version of the EA 400 hydrographic echo sounder, housed in a protected suitcase.

It is compact which makes it the perfect portable echo sounder for surveying in shallow water depths in small, open boats or vessels of opportunity. The system consists of a computer and a General Purpose Transceiver (GPT) housed in a rugged and splash-proof protective suitcase with IP grade 65 and with a window. The computer can be delivered as a standard laptop or a rugged IP rated notebook and can be configured to operate on single or dual frequencies between 38 and 710kHz. In this range the side-scan transducers 120 and 200Khz are also available.

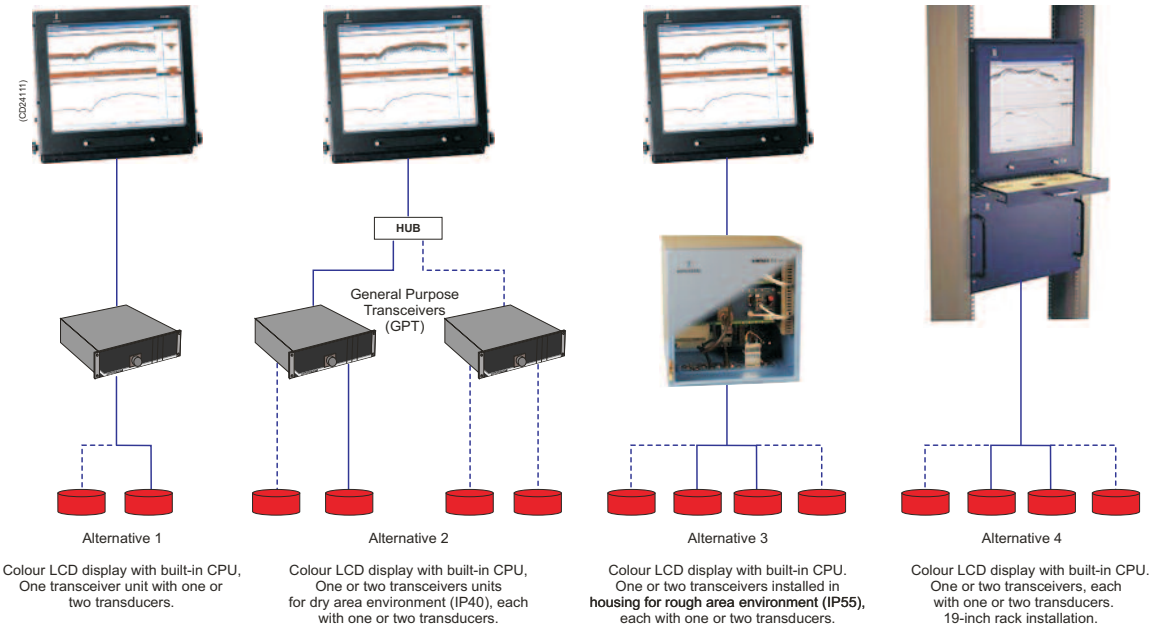
As standard, the EA 400SP unit operates on a DC voltage.

EA 400 Splash proof version.

EA 600 – for deep water applications

EA 600 supports lower frequencies than the EA 400 and is suited for deep water operation. Frequency range is from 10kHz to 710kHz.

The system can have several pulses in the water at the same time, to maintain a high ping rate in deep water environment. It also has functionality for accurate depth tracking of acoustic pingers.



EA 400 and EA 600 system layout, different configurations alternatives.

EA MCU – Multi channel unit

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 detailed bottom imagery.

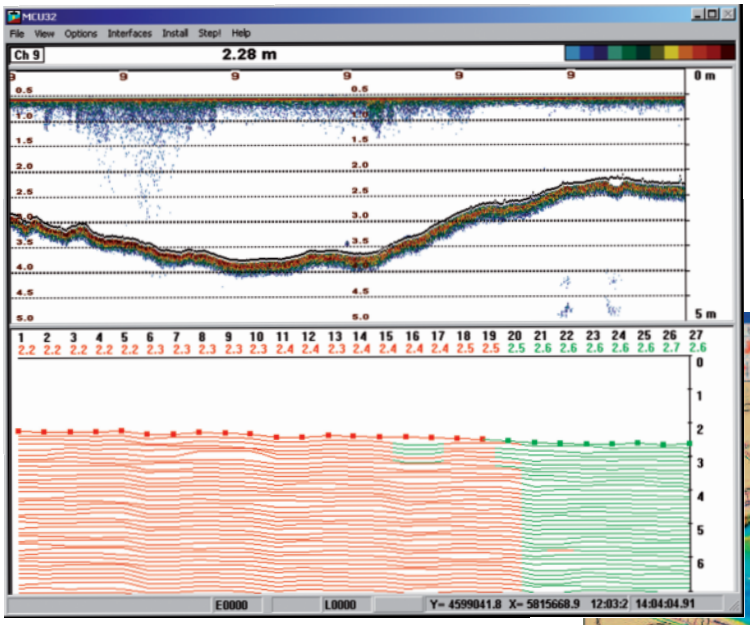
This compact multi-channel echo sounder, based on Microsoft Windows XP operating system, can simultaneously monitor both depth and bottom profile. All data is shown in real time using a color-coded waterfall display which graphically represents areas of common depth using different colors.

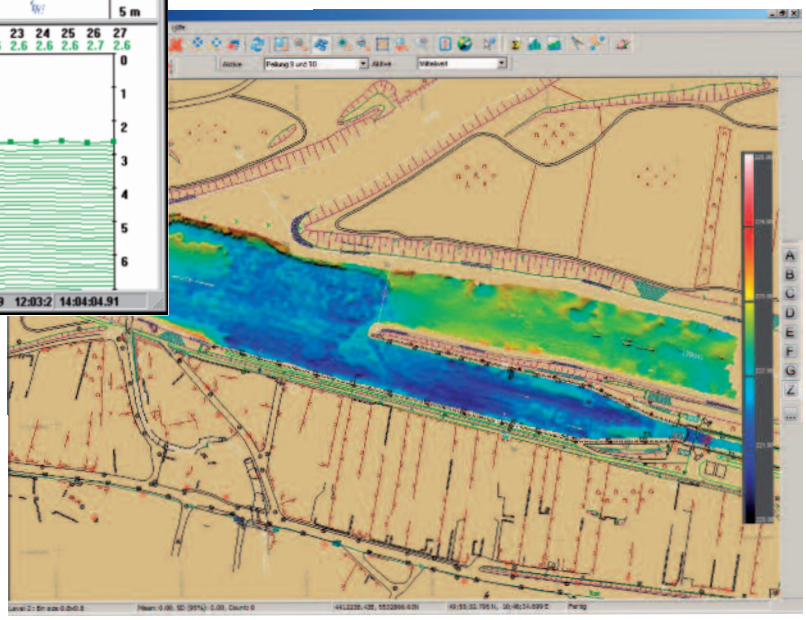
The EA MCU readily detects obstacles and objects on the bottom. Even when targets are covered by mud or sediment, spikes in the waterfall display and abrupt changes in baseline echogram data disclose their locations. By using 15kHz low frequency simultaneously, sub-bottom penetration data is achieved.

The display can view all echograms for quality use.

The EA MCU sweep system has several advantages including:

- Bottom detection capabilities specially suited for use in shallow water
- Consistent and accurate data over an entire sweep
- Replay of raw data
- Simple to configure the x,y, z coordinates of the transducers
- Transducer mode, parameter and display settings stored on the computer's hard drive
- Storing of real time sound velocity (SV) sensor
- Very high pingrate (64 Hz @ 4 m) guaranties hits even on very small targets
- Simultaneous transmit on all transducers
- Interference between neighboring transducers is reduced to zero by using alternate frequencies (180, 220, 180,..)





SIDE SCAN SONAR SYSTEMS

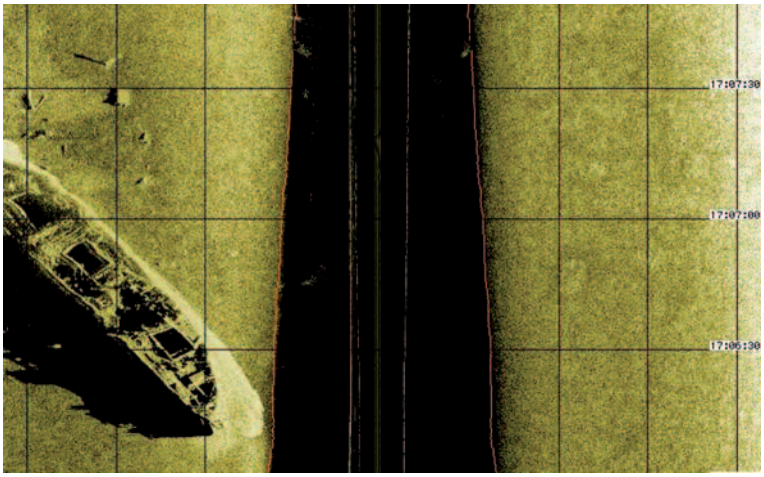
Dual Frequency Side Scan Sonar system

The GeoAcoustics towed dual frequency side scan sonar systems are the ideal tool for seabed feature mapping, offering high quality results in a simple and reliable package.

The system consists of a deck unit and a tow fish, allowing positioning the system at an ideal distance to the target. The system offers dual frequency operation of 114kHz and 410kHz, allowing for wide area coverage and very high resolution surveys and it can be deployed down to 2000 m water depth with cable length up to 7000 m.
For best results the tow fish is deployed at a height above the seafloor of 10% of the expected coverage.

The versatility, ease of operation and reliability has made it a popular choice for navies and commercial survey companies alike.

A range of systems are available to suit different survey applications.

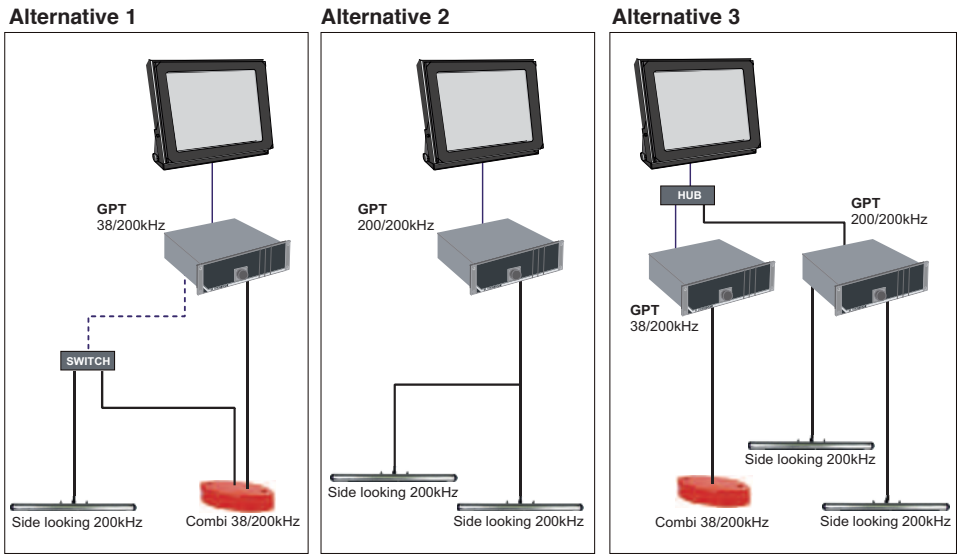


Side Scan data.

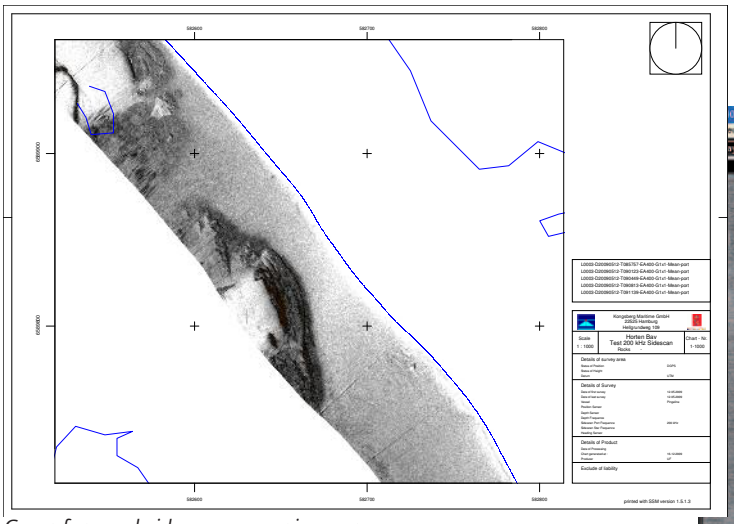

Side Scan tow fish

ECHO SOUNDER WITH COMBINED SIDE SCAN AND DEPTH SOUNDINGS

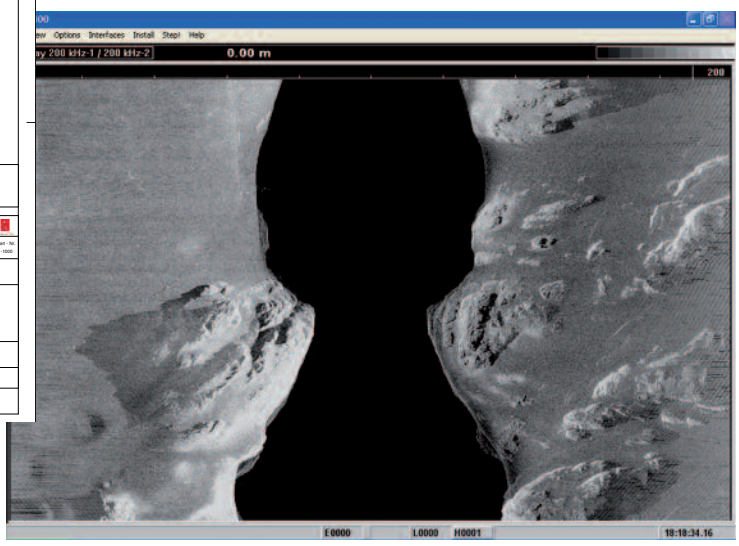
The side-looking sonar is available for the EA 400, EA 400SP and EA 600 hydrographic echo sounders, uses frequencies of 120 and 200kHz and is available in a single and dual version (two transducers). By using a side scan sonar transducer, these echo sounders can produce a side-looking image on the side of the vessel the transducer is located. The system is hull mounted or over-the-side boom mounted side scan transducer(s) to survey shallow areas such as harbors, rivers and canals. This eliminates the need for a towed side scan sonar or similar device. Another advantage is that fixing the correct geographic location of detected objects is made simple and more precisely. It is also possible to allocate one or two vertical channels to normal echo sounding in addition to dual acoustic imaging.



EA 400 side scan, alternative configurations



Geo-referenced side scan sonar imagery.



EA 400 dual 200kHz side scan.

UNDERWATER INSPECTION USING IMAGING SONARS

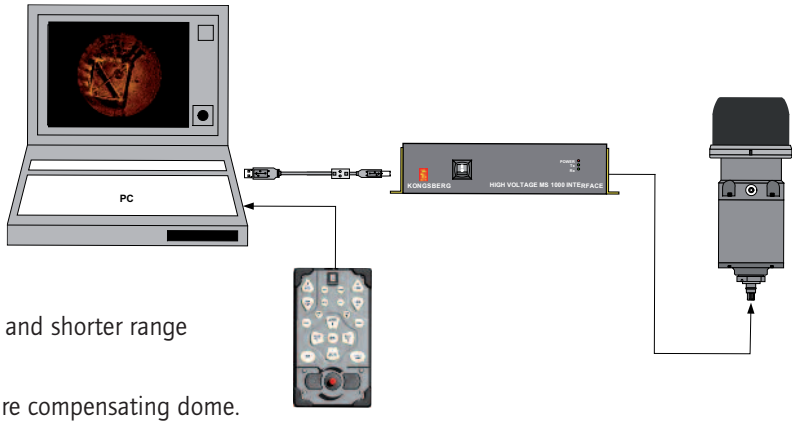
MS 1000 Scanning Sonar

The visualization of underwater structures using imaging sonar heads is essential for many underwater applications and engineering projects. The MS 1000 Scanning Sonar can be used to perform inspection and investigation of structures and targets on the seabed (e.g. shipwrecks, piles) as well as man-made structures (e.g. bridges, jetties, wharves, offshore oil stations etc.) that need to be charted and their condition needs to be inspected for navigation safety purposes.

The MS 1000 Scanning Sonar Processor is a Windows-based application and can be configured to control the complete digital line of Kongsberg Mesotech's scanning sonar, altimeter, and bathy sensor products via industry-standard telemetry protocols.

Dual transducer imaging sonar head

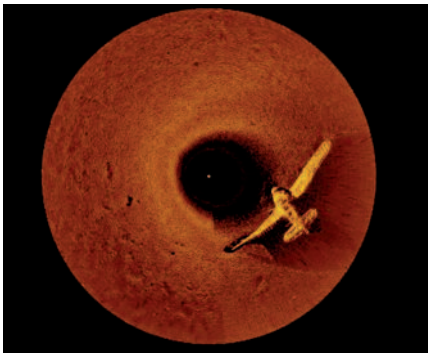
The 1171 Series of sonar heads have been developed to meet the requirements for deep ocean applications and are designed to produce high resolution scanning sonar images.



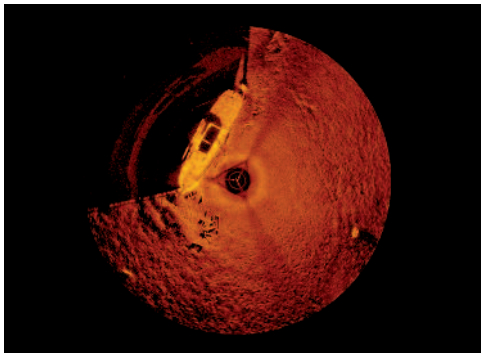
The new sonar heads have reduced size and weight while providing high level of data quality. The dual transducer design allows optimized operational configuration for both long range obstacle avoidance and shorter range imaging detail.
The transducer is protected within an oil-filled, pressure compensating dome.

The telemetry is RS485 and RS232 compatible and is automatically sensed and configured at start up to match the telemetry link used.

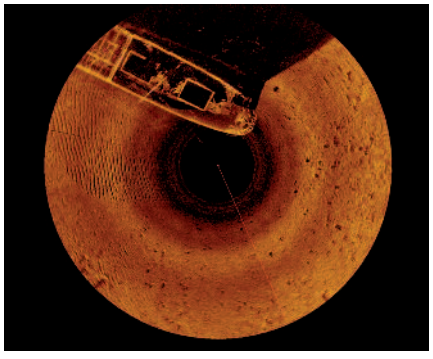
Documentation of aircraft wreckage and shipwrecks using Kongsberg Mesotech's scanning sonar



Aircraft wreckage.
Courtesy of Peter Diving, Russia



Shipwreck.
Courtesy of Brian Abbott, Nautilus Marine Group

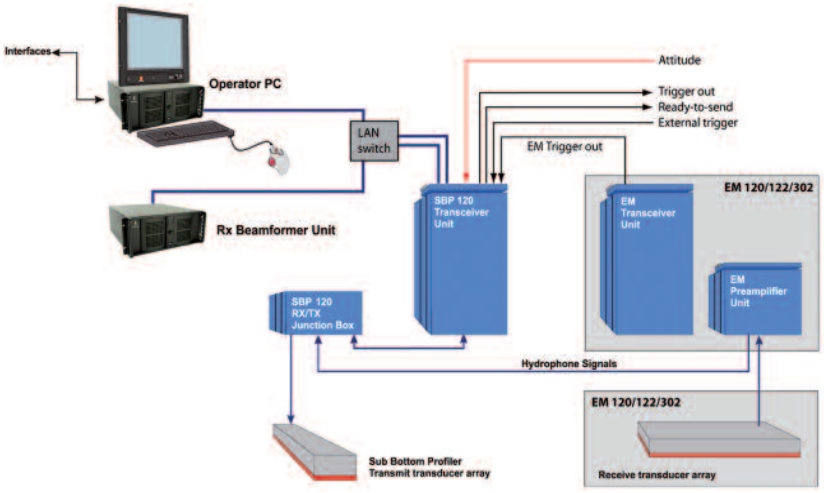


WWII shipwreck at 40m.
Courtesy of Tuukritdööde Oü Commercial Diving, Estonia

SUB-BOTTOM PROFILERS

SBP-120 and SBP-300 Integrated sub-bottom profilers

The SBP-120 and SBP-300 is an optional hull mounted extension to the highly acclaimed EM 122 and EM 302 multibeam echosounders. The primary application of the SBP is to identify, characterize and measure layers of sediment or rock under the seafloor. All systems have excellent penetration and high resolution. They cover all depth ranges from shallow waters to full ocean depth.

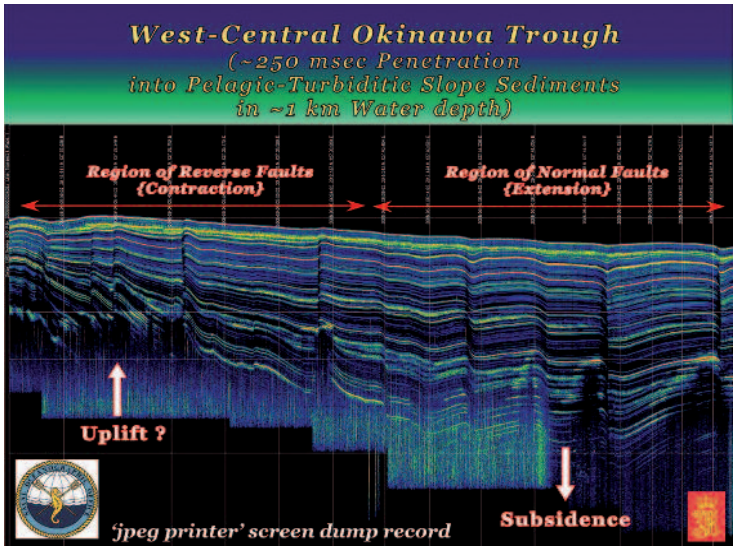


SBP 120/300 system layout

The receiver transducer array of the EM 122 and EM 302 is a wide-band system and by adding a separate low frequency transmitter transducer, electronic cabinet and operator station the EM 122 and EM 302 can be extended to include sub-bottom profiler capacity. Both system have electronic roll, pitch and heave stabilized beams.

The systems have significantly reduced beam widths compared to conventional sub-bottom profilers which is obtained by one linear transmit array mounted along the vessel keel and one linear hydrophone array shared with the EM 122 or EM 302, mounted orthogonally to the keel.

Using a large transmit array increases the source level due to injection of more power without any risk for cavitations and increases the directivity of the transmitter, which also improves the suppression of acoustic noise. Because the transmit beam is wide across-track and all hydrophones are sampled individually the SBP makes a fan of 11 narrow beams across-track per ping inside a 30° sector. This multibeam capacity of the SBP is useful for actually finding of the specular returns in rough terrain, resolving lateral specular returns in rough terrain, detecting buried objects and obtaining information about the angular response of sediments in the seafloor. All beams are electronically stabilized for roll and pitch movements; they can also be steered to take into account the bottom slope. Sound velocity correction is also applied.



SBP 120 survey of West-Central Okinawa Trough.
Data courtesy of NAVOCEANO.

The transmit waveform is a linear FM chirp ranging from 2.5 - 7kHz, providing a maximum vertical resolution of approximately 0.3 milliseconds. 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 with a multi-pulse mode available (for generating several pulses in the water). The system can be operated in a synchronised mode by running simultaneously with the EM 122 or EM 302 multibeam echo sounders. Systems are offered as a three, six and twelve degree transmit system.

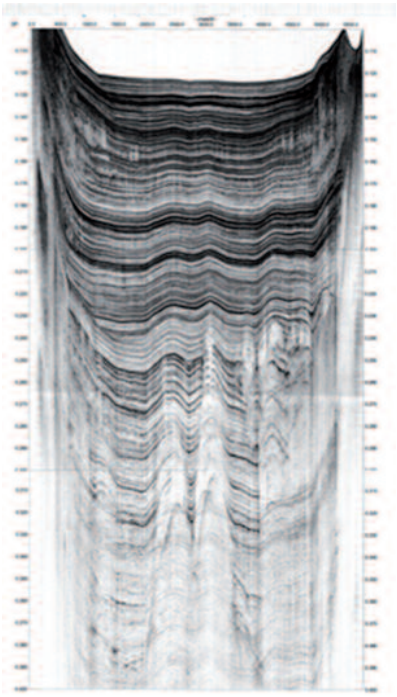
Geo Pulse and GeoChirp Sub-Bottom Profilers

GeoAcoustic Sub-Bottom Profilers have versatile deployment options, towed, over-the-side or hull mounted. They can be found on small survey launches in shallow water environments as well as ocean going vessels for deep water operations.

GeoPulse

The GeoPulse is the survey industry's standard Sub-Bottom Profiler pinger system.
Its proven success is due to its reliability, ruggedness, ease of operation and flexibility.
Sub-Seabed structures are delineated using reflections from a selectable single frequency multi-cycle high power signal.

GeoPulse Towed version.

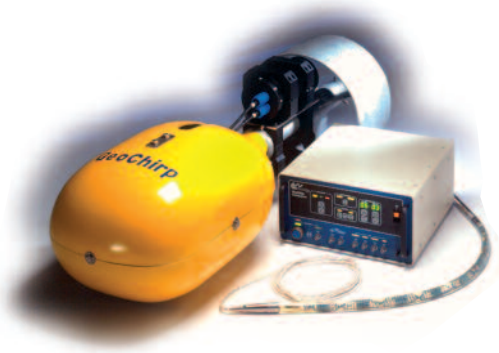


GeoPulse data, Lake Chala, Kenya.
Data courtesy of Renard Centre of Marine Geology, Gent, Belgium.

GeoChirp II

The GeoChirp II delineates the sub-surface using reflections from the frequency modulated source signal. Due to chirp pulse compression and digital signal processing techniques it achieves deep penetration, whilst attaining high resolution.
The operator can choose from a range of waveforms, or program his own signal, depending on the survey task.

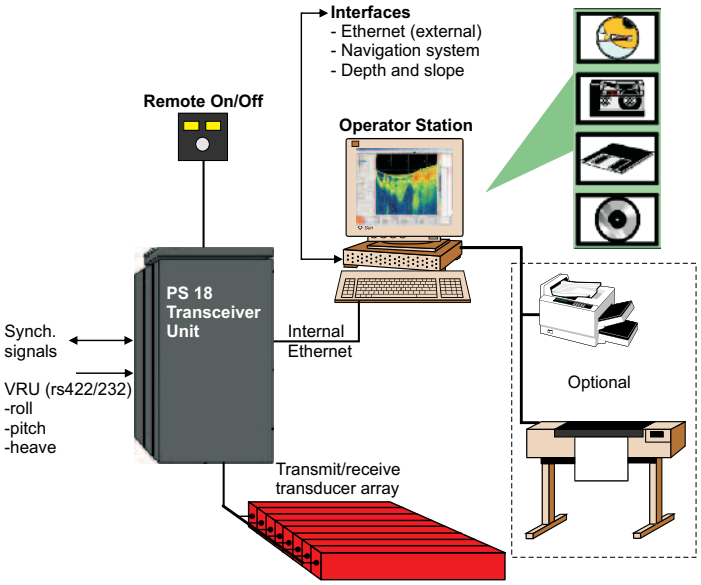
The Sub-Bottom Profilers can be combined with the Dual Frequency Side Scan Sonar System into a single shallow- or deep-towed vehicle that easily can interface to a towed magnetometer to complete the survey suite.



GeoChirp II towed version.

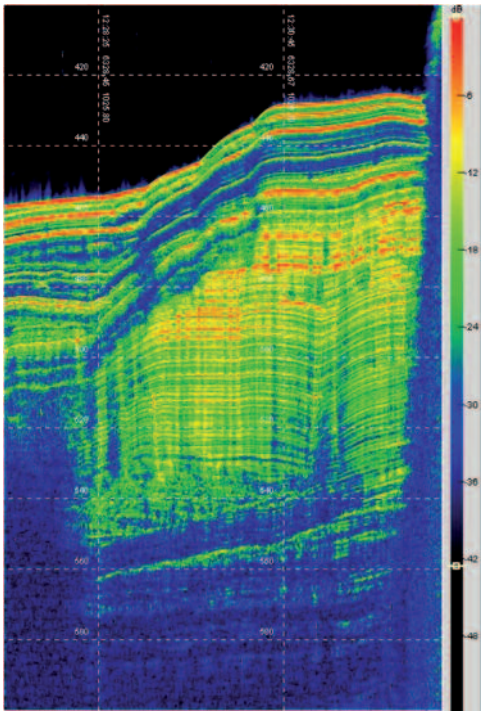
TOPAS PS 18 and PS 40 (TOpographic PArametric Sonar)

Both the PS 18 and PS 40 are parametric Sub-bottom Profilers designed to do high-resolution sub-bottom profiling and object detection. The PS 18 operates in water depths from about 20 meters to full ocean depth, while the PS 40 is design to operate from less than 5 meters to more than 1000 meters water depth.



Both systems are hull mounted with electronic roll, pitch and heave stabilized beams, which makes them an efficient tool in all kinds of accurate, high-resolution survey operations. Since there is no need for towed equipment, survey speed can be increased to more than 12 knots.

The TOPAS sub-bottom profilers are designed around a parametric end-fire antenna.
This principle is used in order to achieve the high directivity, low frequency beam from a small transducer area.
The systems can electronically compensate for heave, roll and pitch movement of the vessel and optionally perform a sequential beam scanning over a sector of up to 90 degrees generating a sub-bottom swath for building up 3D displays of sub-bottom sediments in one pass.
The parametric antenna utilizes the effect of the non-linear propagation properties of water when a high intensity, acoustic waveform is transmitted. As the wave propagates, harmonics are generated, as long the intensity is sufficiently high. By transmitting two sinusoidal waveforms, around 18kHz for the PS 18 and 40kHz for the PS 40, simultaneously along the same acoustical axis, difference and sum frequencies are formed. The sources for these waveforms are the water volume where the two primary waveforms have sufficient level for non-linear interaction. The duty cycle and total transmitted energy limit the ping rate. For short single pulses, maximum ping rate is typically 5 Hz for the PS 18 and 10 for the PS 40. For long waveforms like chirp signals, maximum ping rate depends on the chirp length. When operated in conjunction with multibeam systems in deep waters, the ping rate may be lower to avoid interference.



TOPAS PS 18 data from medium water.
Courtesy of IMR, Norway.

SYNTHETIC APERTURE SONAR SYSTEM

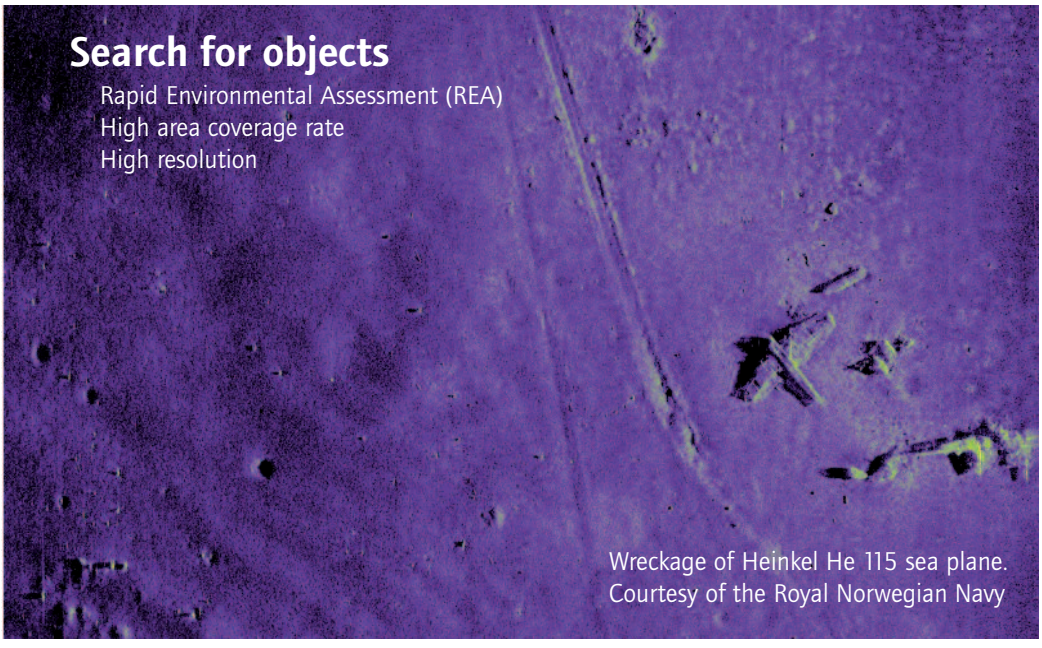
HISAS 1030

HISAS 1030 is an interferometric synthetic aperture sonar system capable of providing very high resolution images and detailed bathymetry of the seabed.

Originally developed for demanding military mine countermeasures (MCM) operations, where there is a need to detect and classify small objects on the seafloor in a challenging clutter filled environment. The sonar is installed onboard HUGIN 1000, a medium size AUV in Kongsberg's family of AUVs.
The HiSAS has a range-independent resolution of approximately 3 x 3cm out to a distance of more than 200m 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 even in challenging, cluttered environments and with a typical area coverage rate of 2 km^2/hr.

As the height map is generated at near image resolution, it is possible to generate bathymetric estimates both at side-scan and full SAS resolution. This allows rapid collection of large swathes of bathymetric information at low processing cost, while simultaneously allowing extremely detailed bathymetric imagery to be generated for selected regions.
By merging HISAS 1030 side scan bathymetry with data from the EM 3002 / EM 2040 multibeam, a single swath of up to 20 times the altitude of the AUV above the seafloor 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 and a balanced approach to achieving optimal performance from the SAS system.
For mode information about the HiSAS 1030 and the HUGIN AUV please refer to the respective family brochures.



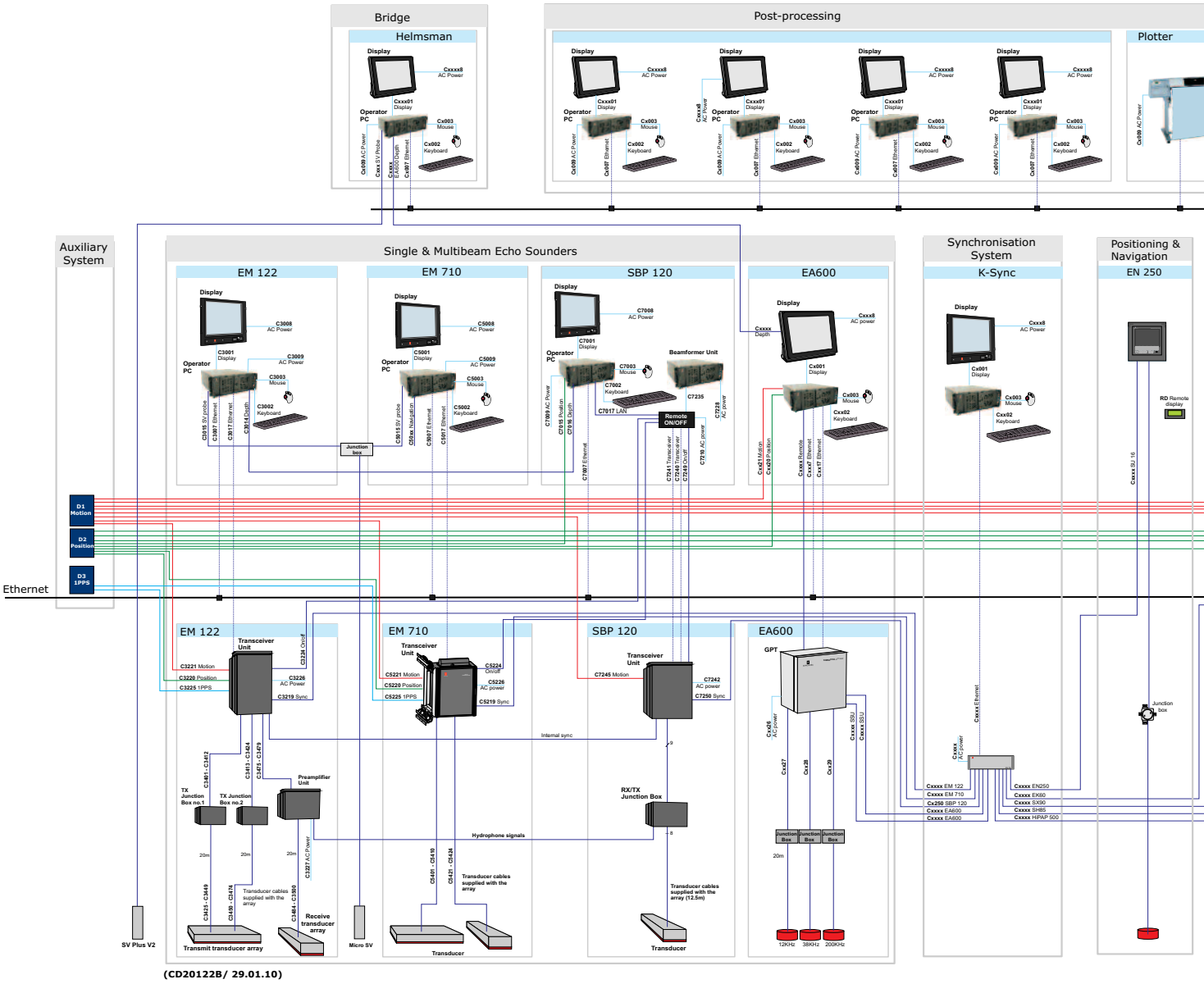
Wreckage of Heinkel He 115 sea plane.
Courtesy of the Royal Norwegian Navy

INTEGRATED SOLUTIONS

Delivery of large integrated packages

Throughout the years we have been involved in late generation work on many vessels, especially when built from scratch, having a complex equipment configuration with equipments from many vendors including Kongsberg Maritime.

Even though our core business is delivery of multibeams, singlebeams and so on, the growing trend is that the customer engages us to also deliver 3rd party products and also to take a share of the total system integration. This has evolved from the original situation in which we had the responsibility to install our own equipment to a situation where we are responsible for a much wider range of equipment integration and this is true especially for research vessels. The scientific work carried out on these vessels very seldom involves only one instrument, but a range and all producing a steady stream of data that has to be stored, organized and made available.



Example of an integrated solution.

When taking on a wider responsibility for the commissioning of instrumentation packages on such ships, our task is to provide an integrated solution based on the specifications from the customer and in close cooperation with both the customers project team and with the various vendors involved.

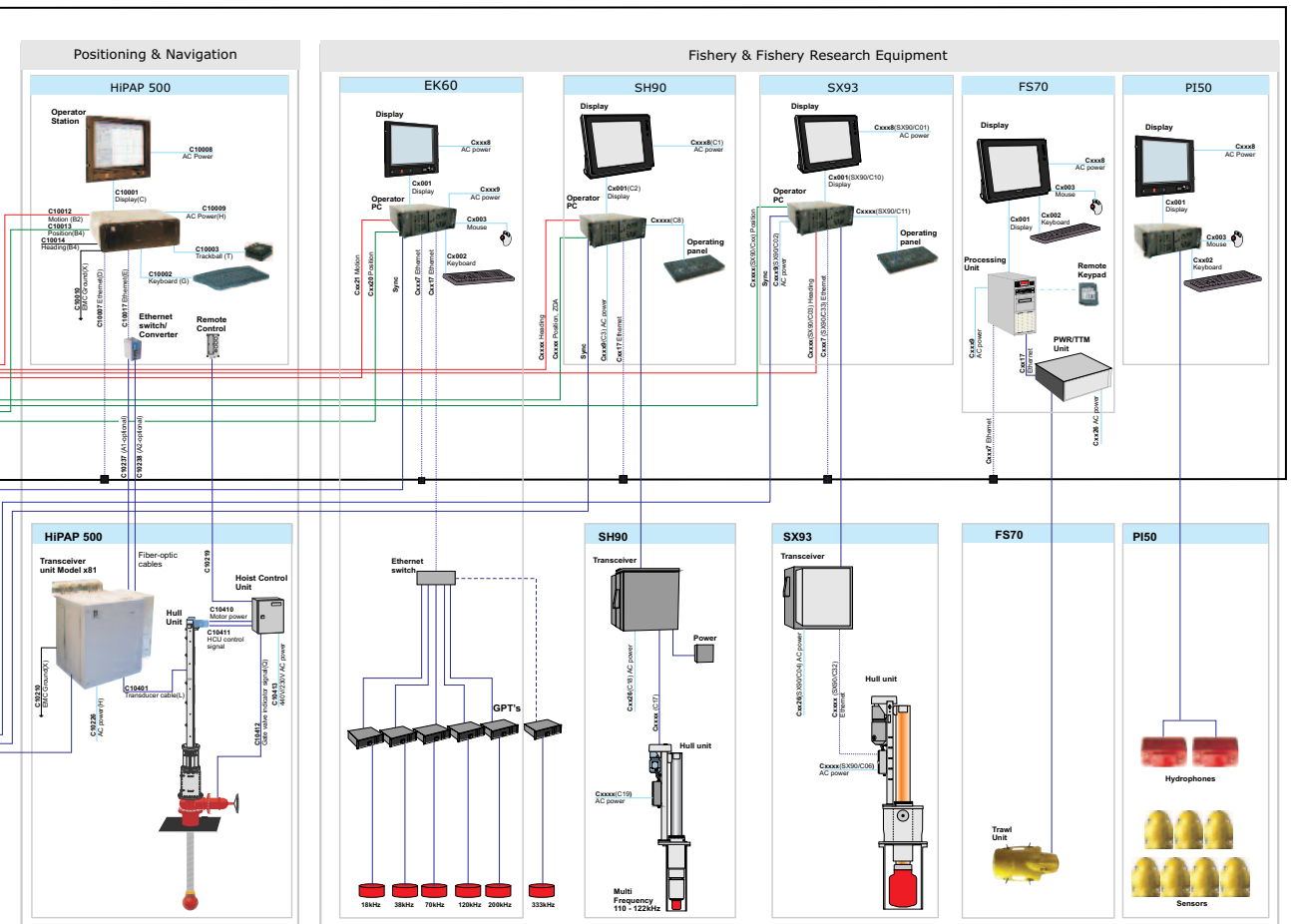
Kongsberg Maritime has an incomparable history in delivering large integrated packages for specialized vessels and applications, such as:

- Offshore Survey
- Naval/Hydrographic
- Offshore Exploration and Construction
- Oceanographic/Research

Example of console arrangement for integrated systems

There are many benefits for the customer by using the integrated solutions provided by Kongsberg Maritime:

- More Manageable Logistics
- One Source and one point of contact
- Single Source of Responsibility
- Easier planning
- Streamlining delivery
- Coordinated Maintenance



MDM – Data management system

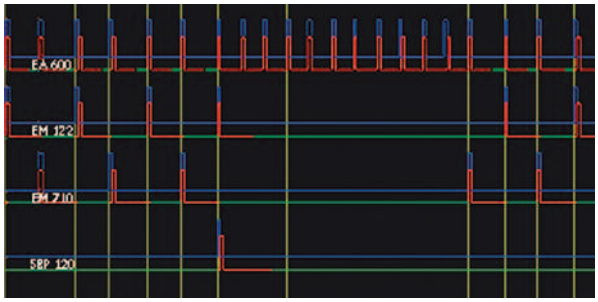
A typical research vessel involves integration between systems like Multibeam Echosounders, Single beam echo sounders, Fishery Sonars, Dynamic Positioning, Navigation echo sounders, position systems, motion sensors, meteorological sensors, hydrological sensors and scientific workstations with many displays located all over the vessel.

Data from all these sensors do not always have the same importance, and not all data samples need to be stored, but can be reduced to a more manageable amount. The MDM has been developed for easy interfacing and storing of an extract of data from a range of scientific sensors onboard the vessel to a centralized database server. The system can through different tools extract data from the database, perform some rudimentary processing and present the results in various reports.

K-SYNC Synchronization unit

It is well known that running several acoustic systems simultaneously can cause interference between the systems, which may reduce the data quality. Interference between different acoustic devices and instruments can be a severe problem for ships with several acoustic instruments operating simultaneously. The effect of such interference will vary according to the configuration, from slight disturbances to complete malfunctioning. The Kongsberg synchronizing unit, K-SYNC is designed to solve these problems by proper timing of the instruments and by controlling the triggering of each instrument' s transmission.

The system is interfaced easily to many different acoustic systems and the operation is through a simple but efficient user interface with a real time graphic display that visualizes the sequencing.



K-Sync graphic display showing systems' sequencing.

K-Sync syncronizing unit components.

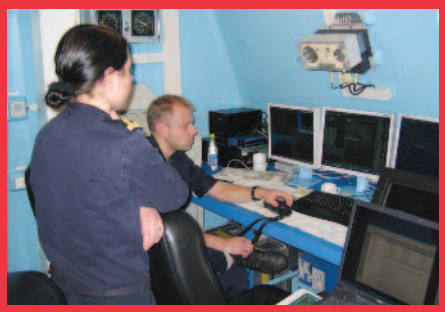
We are always there, wherever you need us

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 well-qualified field service engineers will be able to help you quickly and effectively.



Solid competence reduces cost

We have always recognised the importance of supporting our products and systems with professional training.

A wide range of courses are therefore offered to ensure that you achieve the goal of full system utilisation with safe and efficient operation.

Upgrading that pays

Product and system upgrades can improve your vessel's operations and reduce your overall maintenance costs. We will ensure that existing products and systems can be extended or upgraded based on standard upgrade kits.

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