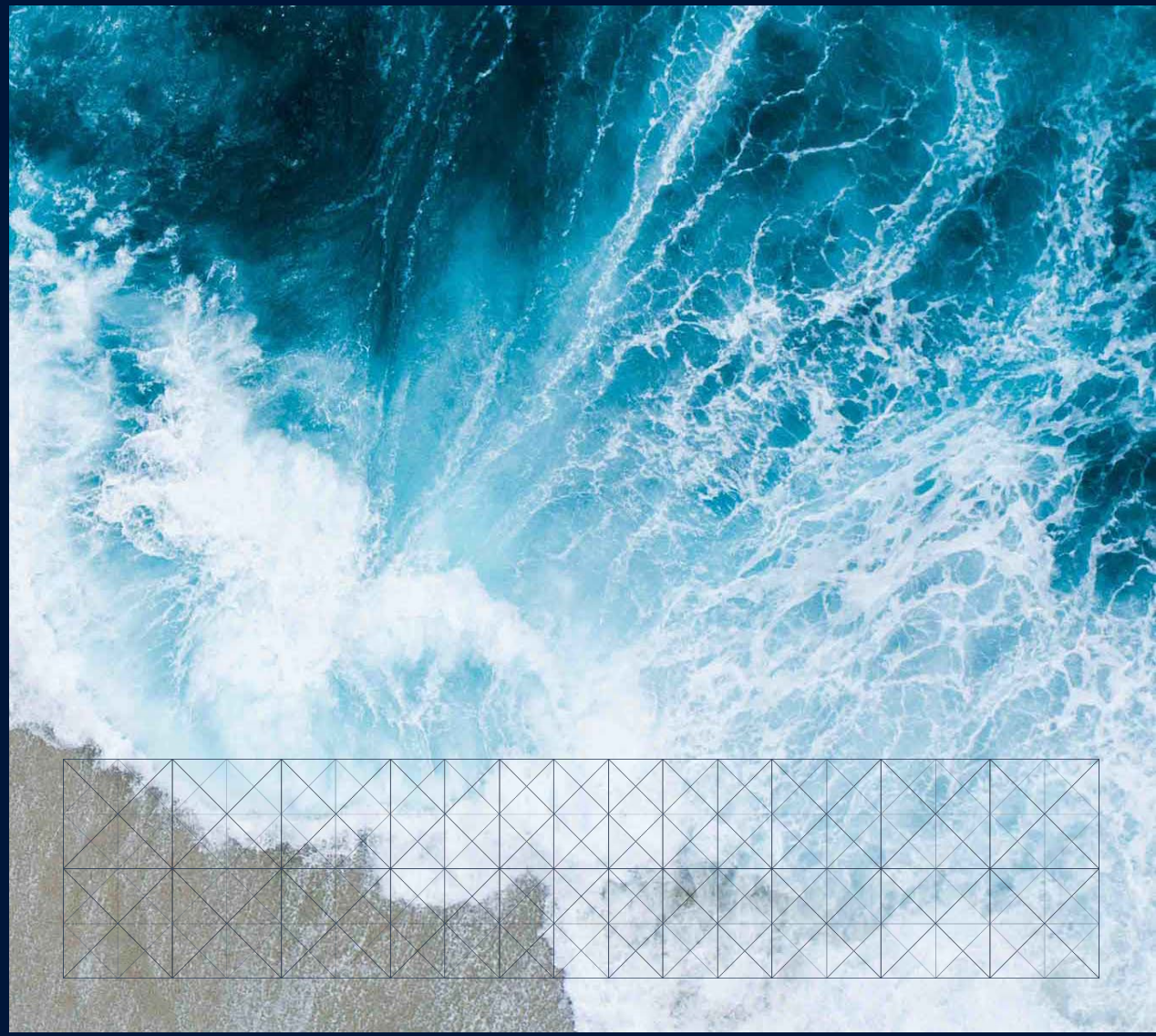
KONGSBERG

Kongsberg Maritime

13/07/2020



Jake Sobin

KONGSBERG

Agenda

1. Introduction
2. Acoustics - Active Systems
3. Scientific Research Vessels
4. Positioning, Navigation and Communication
5. Marine Robotics

KONGSBERG

KONGSBERG

A leading global technology company

11 000
EMPLOYEES

40
COUNTRIES

2020

200+
Year History

3
BUSINESS AREAS

*Preliminary proforma consolidated figures 2018

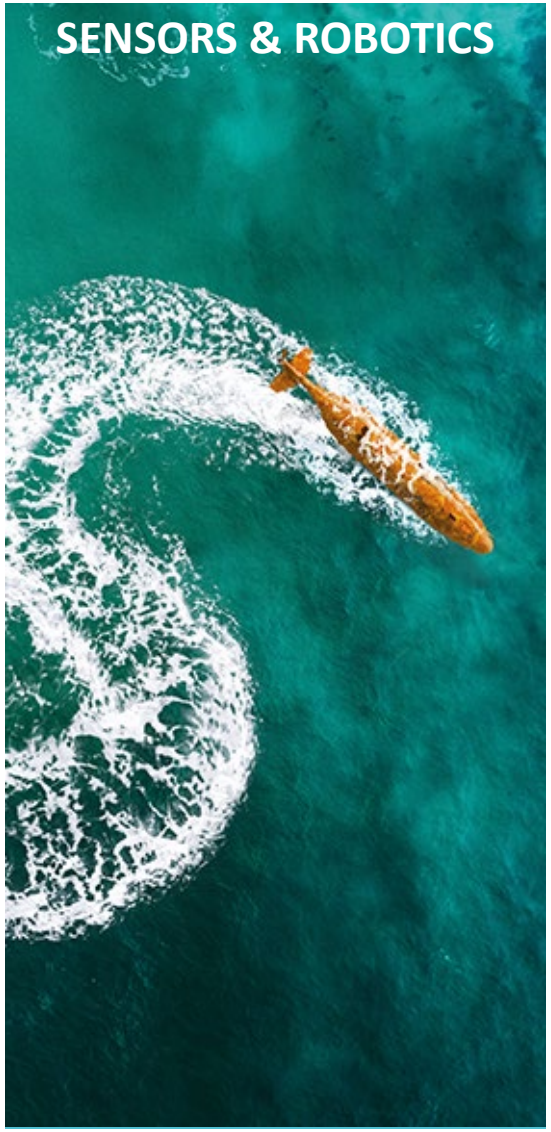
3 Key Business Areas

KONGSBERG is a global technology powerhouse

KONGSBERG

Kongsberg Maritime

The broadest portfolio of products for the maritime industry



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Kongsberg Maritime Offices

NORWAY

Horten (Strandpromenaden) - Underwater navigation, echo sounders, sonars, autonomy

USA

Houston - Kongsberg Maritime Inc.

New Orleans (St. Rose) - Kongsberg Maritime Inc.

Seattle (Lynnwood) - Kongsberg Underwater Technology LLC

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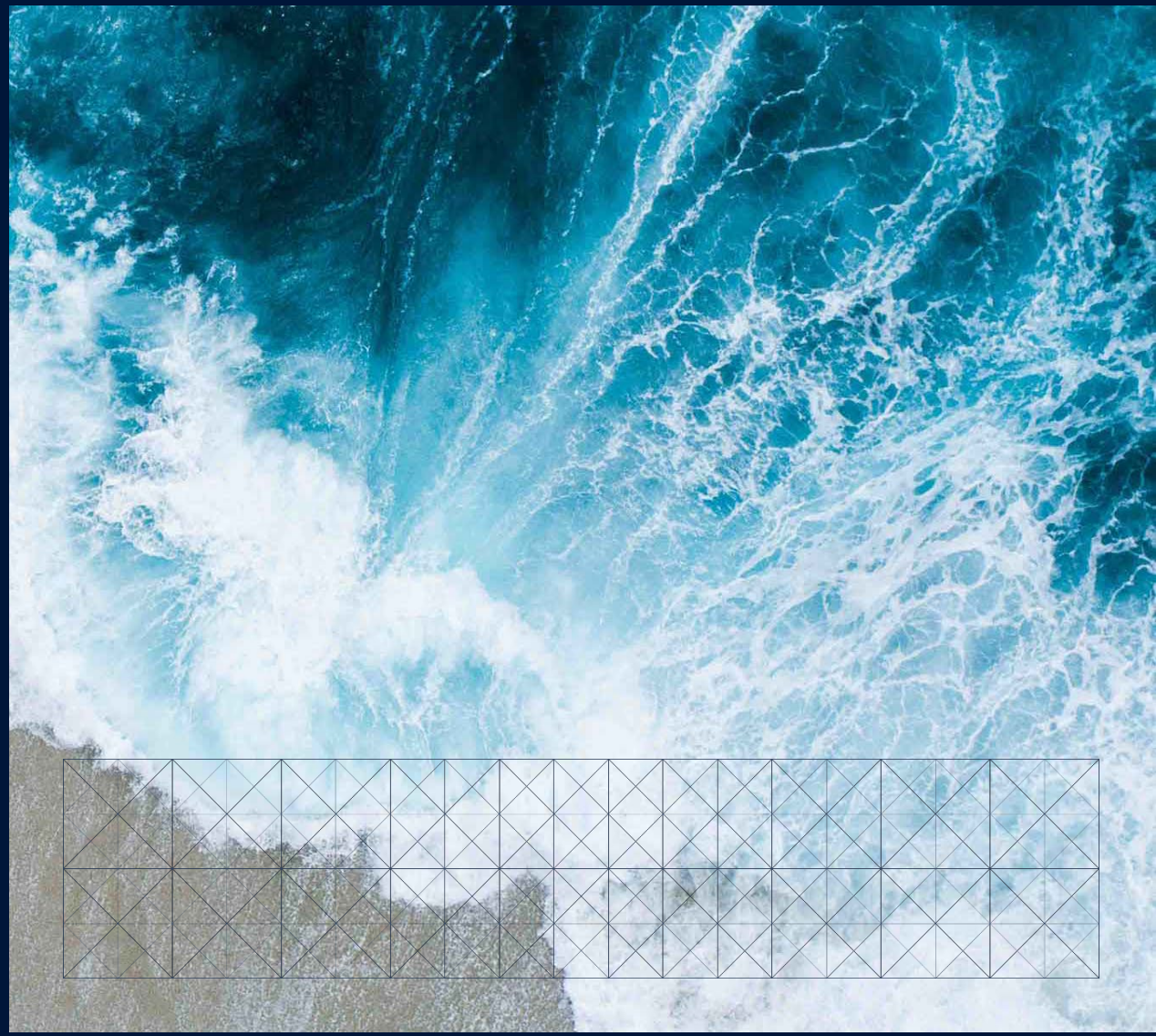
Acoustics - Active Systems

Jeff Condiotty



EK Echo Sounder Family History

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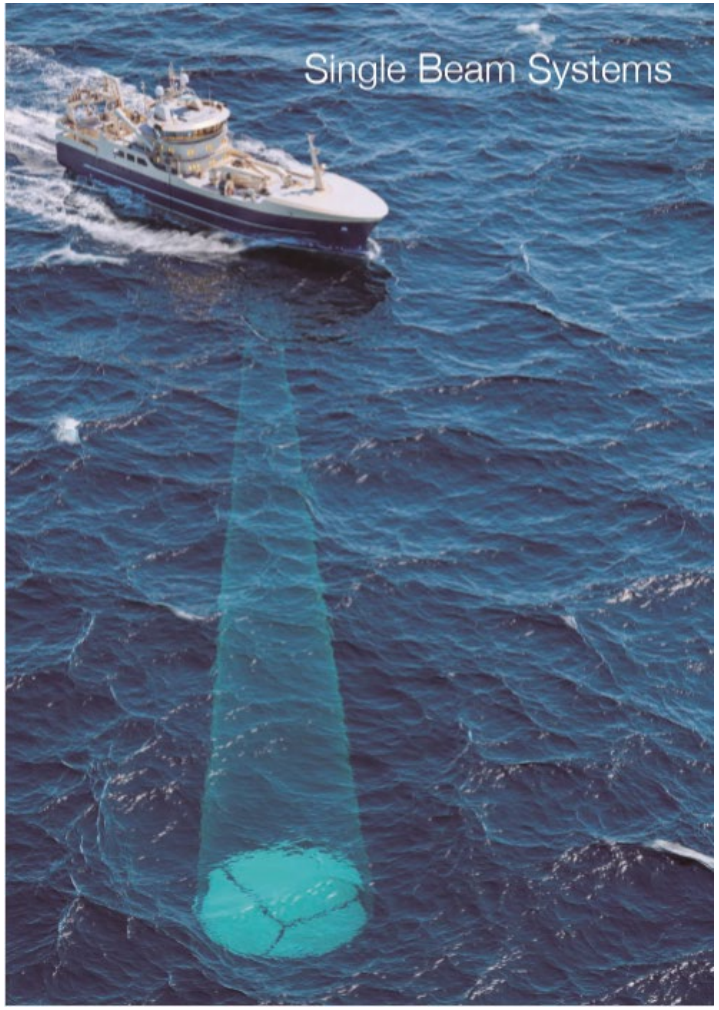


EK500 1988

EK500 functionalities
- Digital echosounder
- High dynamic range for echoes
- 3 split-beam transducers 12/38/120kHz
- Built-in sphere calibration tool

EK60 2001

EK60 functionalities
- 6 split-beam transducers 18/38/70/120/200/333 kHz
- Easy to use and compact
- PC interface

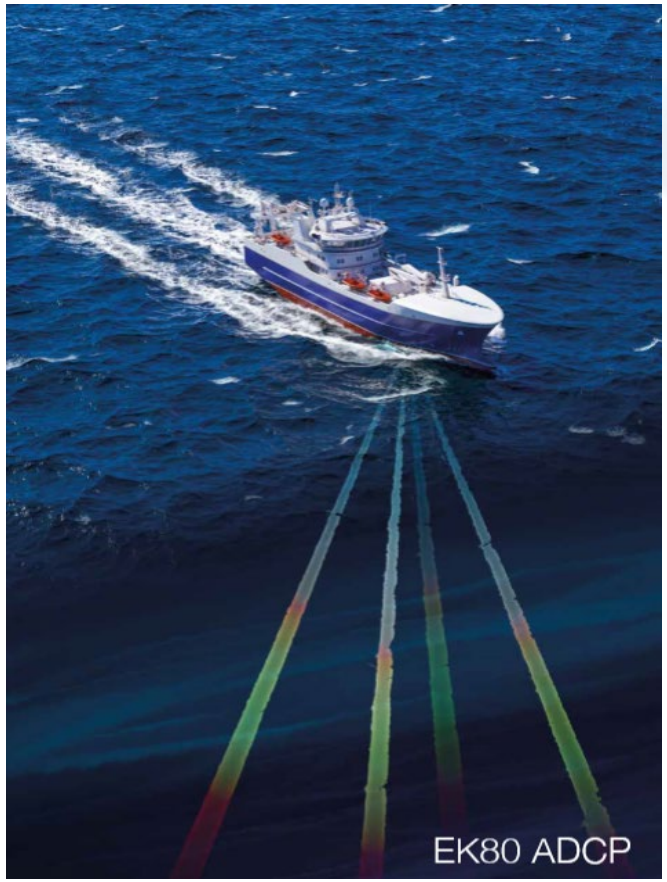
EK80 2016

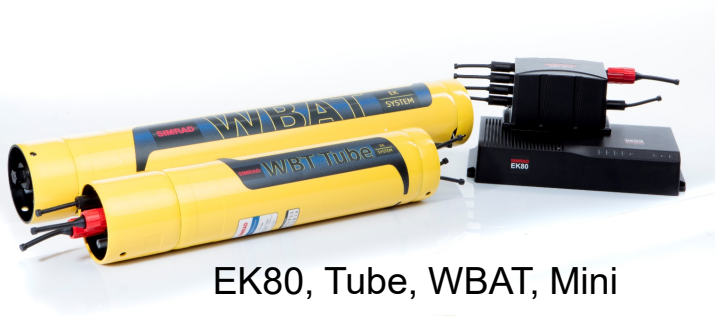
EK80/ADCP 2019

EK80 functionalities
- Broadband signal [14-450] kHz
- More split-beam transducers for integration on many platforms (AUV, buoy, observatory, CTD,…)
- **ADCP transducer with built-in electronic**

Ocean Science Products

Echo Sounders, Transducers, ADCP and Engineering Services



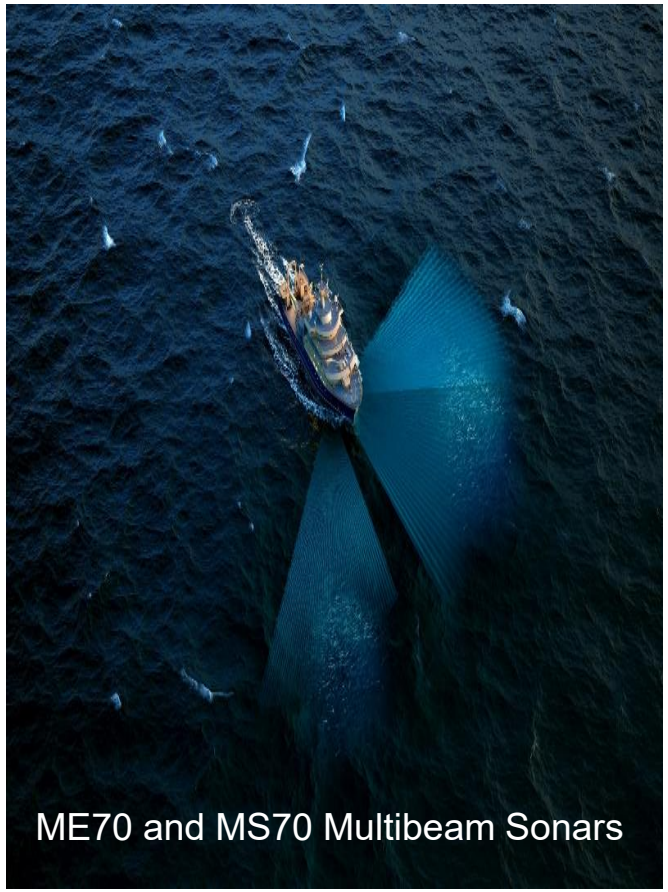


EK80, Tube, WBAT, Mini

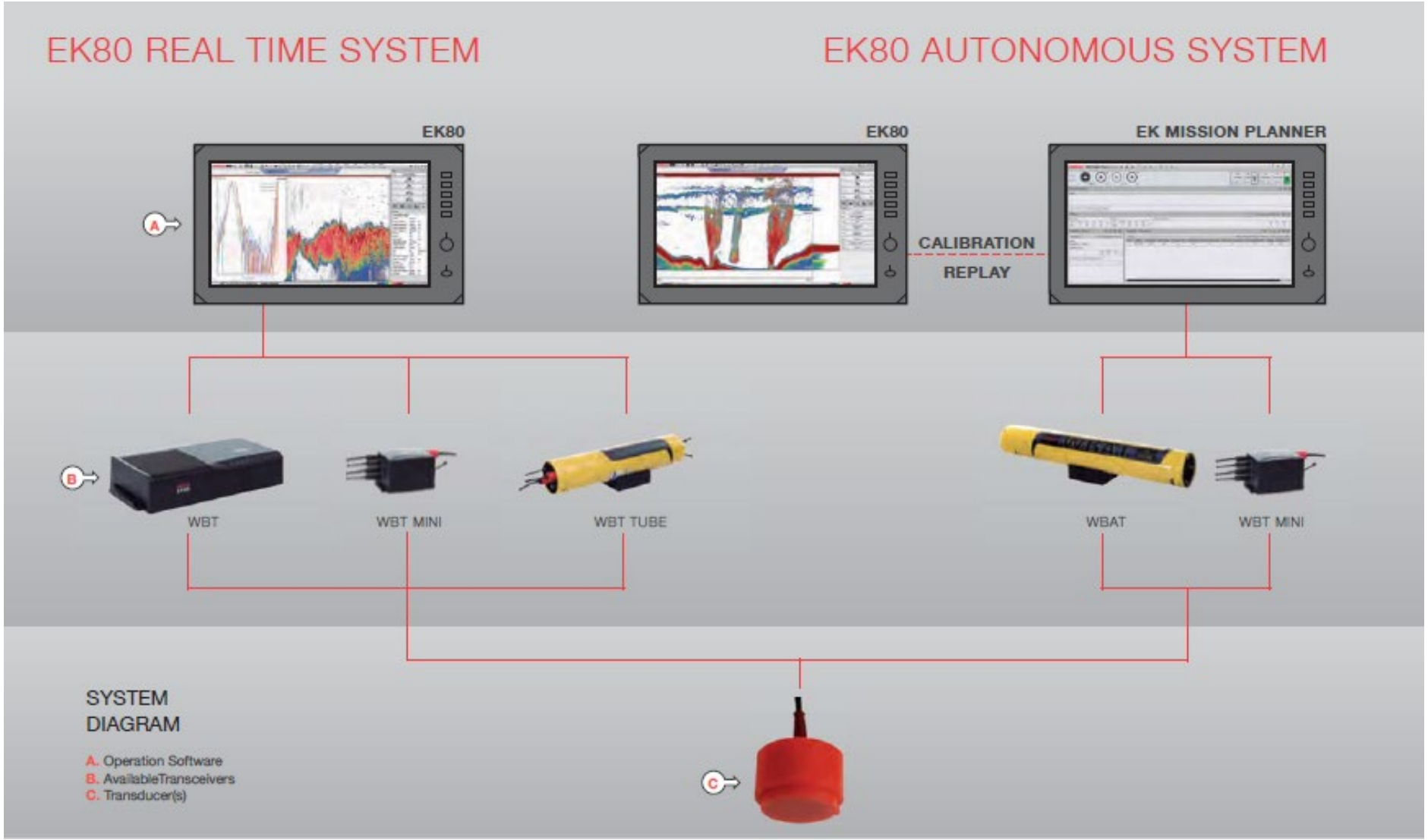
Transducers

EK80 Mini Portable

EK80 EC150 ADCP



EK80 Family



NOAA Fisheries – Stock Assessment Survey, Research

8 ships

- Fishery Survey Vessels (FSV)
  - ME 70 / **EK 80** / Trawl *Oscar Dyson*
  - ME 70 Bathy Option / EK 60 (5) / Trawl *Henry B. Bigelow*
  - ME 70 / EK 60/80 / Trawl *Pisces*
  - ME 70 / EK 60 / Trawl *Bell M. Shimada*
  - ME/MS 70 / **EK 80** / SX90 /Trawl *Reuben Lasker*
- Coastal Research Vessels
  - EK 60 *Gordon Gunter*
  - EK 60/80 *Oregon II*
  - EK 60 *Oscar Elton Sette*
- Ocean Exploration
  - **EK 80** *Okeanos Explorer*

Transceivers




	WBT	WBAT	WBT Tube	WBT Mini
Power	External	Internal battery	External	External
Transmit power	4 x 500W	4 x 250W	8 x 250W	4 x 250W
Control	EK80	Mission Planner	EK80	EK80 **or** Mission Planner
Multiplexing	-	Built-in	Built-in	Built-in
# channels	4	4 + MUX	8 + MUX	4 + MUX
External interface	-	RS-422	-	RS-422
Pulse length	64µs to 8ms	64µs to 2ms	64µs to 2ms	64µs to 2ms
Pulse types	CW, chirp, active, passive, custom	CW, chirp, active, passive	CW, chirp, active, passive	CW, chirp, active, passive
Transducer types	Single and/or split-beam	Single and/or split-beam	Single and/or split-beam	Single and/or split-beam
Depth rating	-	1500 meters	4000 meters	Splash proof
Frequency range	10 to 500 kHz	30 to 500 kHz	30 to 500 kHz	30 to 500 kHz
Licensing	Yes	No	Yes	Yes / No

Transducers - Standard

Surface installation





	ES18	ES38-7	ES70-7C	ES120-7C	ES200-7C	ES333-7C
Nominal frequency [kHz]	18	38	70	120	200	333
Nominal opening angle [deg]	11	7	7	7	7	7
Nominal max TX power [W]	2000	2000	750	250	150	50
Approx. frequency band [kHz]	18	35 – 45	45 – 95	90 – 170	160 – 260	280 – 450
Approx. opening angles [deg]	11	7.8 – 5.9	10.9 – 5.2	9.3 – 5.0	8.8 – 5.4	8.3 – 5.2
Depth rated	No	No	No	No	No	No
Sectors	4	3+1	4	4	4	4
Diameter [cm]	63	48	28	18	12	12
Weight in air [kg] (20 m cable)	85 (w cable)	68 (w cable)	6.4 (wo cable)	2.4 (wo cable)	4.2 (w cable)	4.2 (w cable)

Transducers – Depth rated

Low sidelobes

	ES38DD	ES70-7CD	ES120-7CD	ES200-7CD	ES333-7CD
Nominal frequency [kHz]	38	70	120	200	333
Nominal opening angle [deg]	7	7	7	7	7
Nominal max TX power [W]	2000	750	250	150	50
Approx. frequency band [kHz]	38	45 – 90	90 – 170	160 – 260	280 – 450
Approx. opening angles [deg]	7	10.9 – 5.4	9.3 – 5.0	8.8 – 5.4	8.3 – 5.2
Depth rated (std. 1500 m)	Yes	Yes	Yes	Yes	Yes
Sectors	4	4	4	4	4
Diameter [cm]	48	28	18	12	12
Weight in air [kg]	58	16	4.5	2	2

Transducer – Depth rated

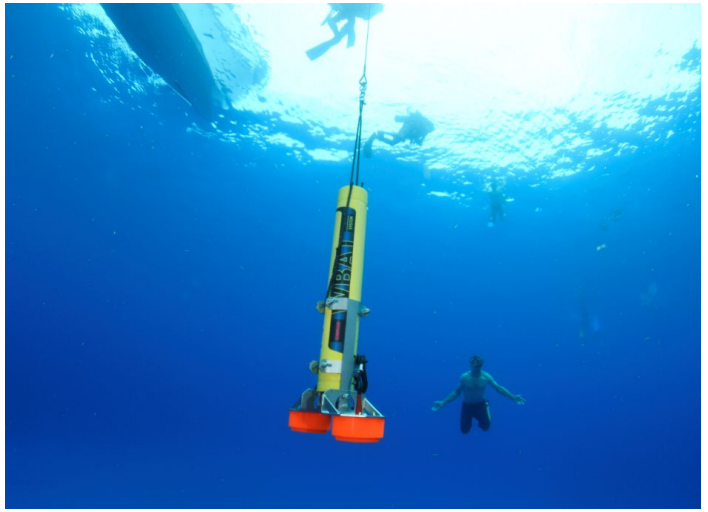
Compact

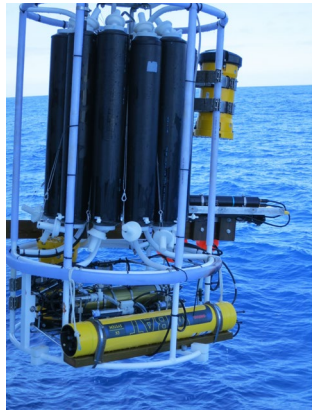
	ES38-18DK	ES70-18CD	ES200-7CDK	ES333-7CDK
Nominal frequency [kHz]	38	70	200	333
Nominal opening angle [deg]	18	18	7	7
Nominal max TX power [W]	450	400	150	50
Approx. frequency band [kHz]	35 – 45	55 – 90	185 – 255	270 – 445
Approx. opening angles [deg]	19.5 – 15.2	22.9 – 14	7.6 – 5.5	8.6 – 5.2
Depth rated (std. 1500 m)	Yes	Yes	Yes	Yes
Sectors	3	4	3	3
Diameter [cm]	19	18	9	7
Weight in air [kg]	9.2	4	0.85	0.55

Ocean Science Platforms

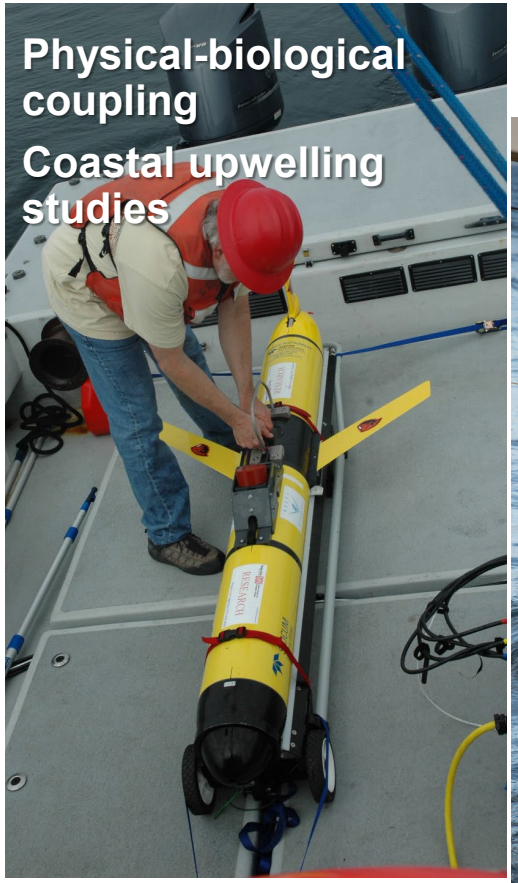
Ships (all sizes), autonomous platforms (surface and bottom / cabled and un-cabled)

NOAA Ship *Oscar Dyson* aerial photo



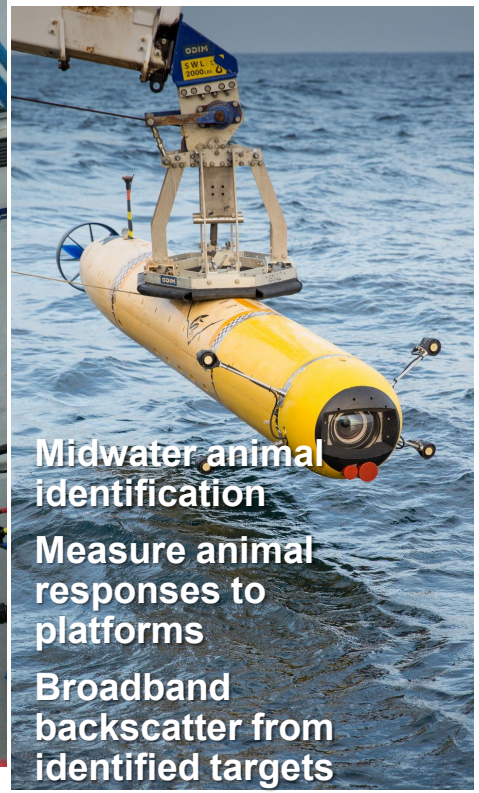


EK80 Mini autonomous mode applications



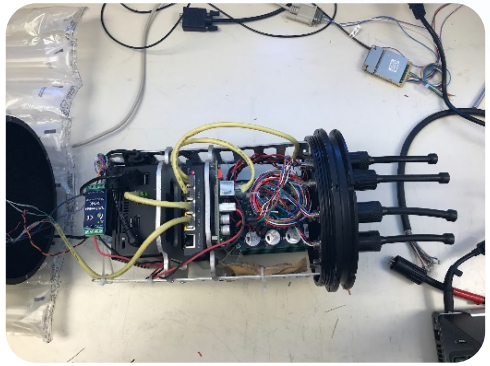
Monterey Bay Aquarium Research Institute

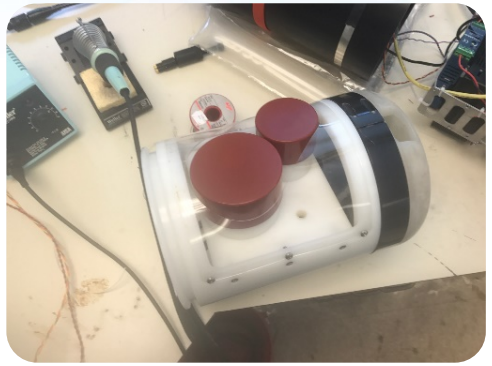
WBT Mini



2 WBT Mini

EK80 Mini Installed Within REMUS 100





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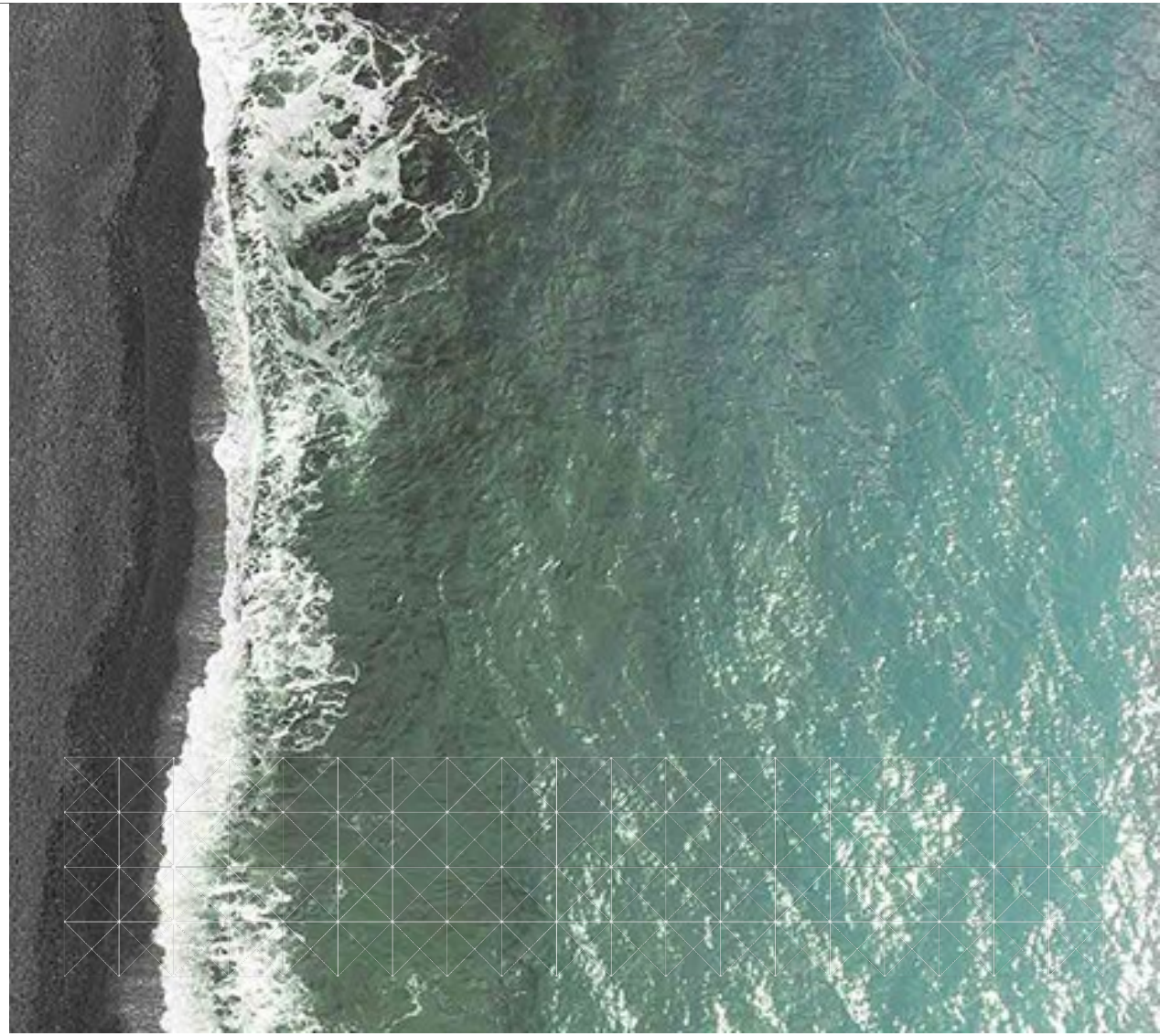
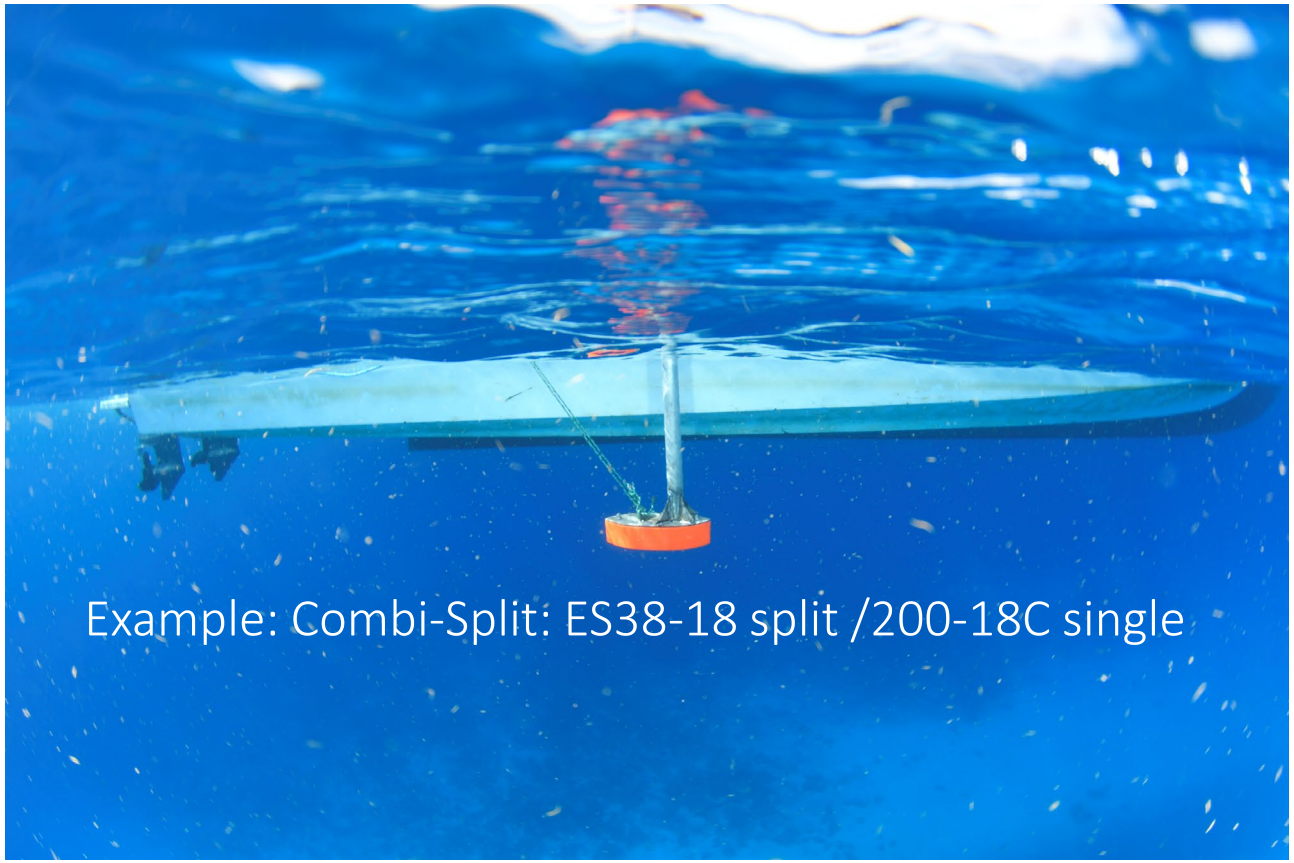
NEW PRODUCTS



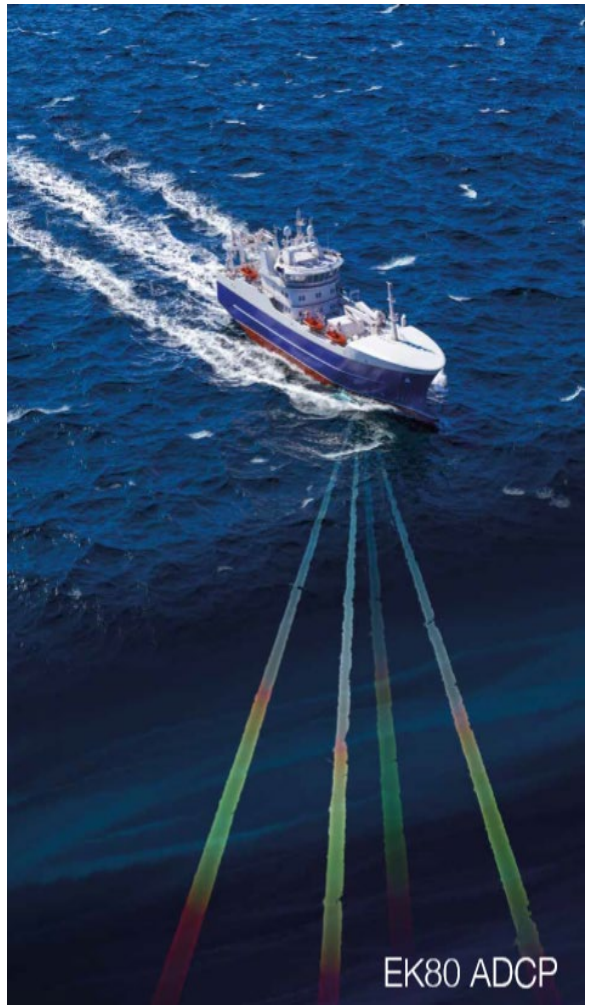
EK80 Mini Portable

+ EK80 Licensed software
+ WBT Mini
+ Computer
+ GPS
+ Echoview post processing

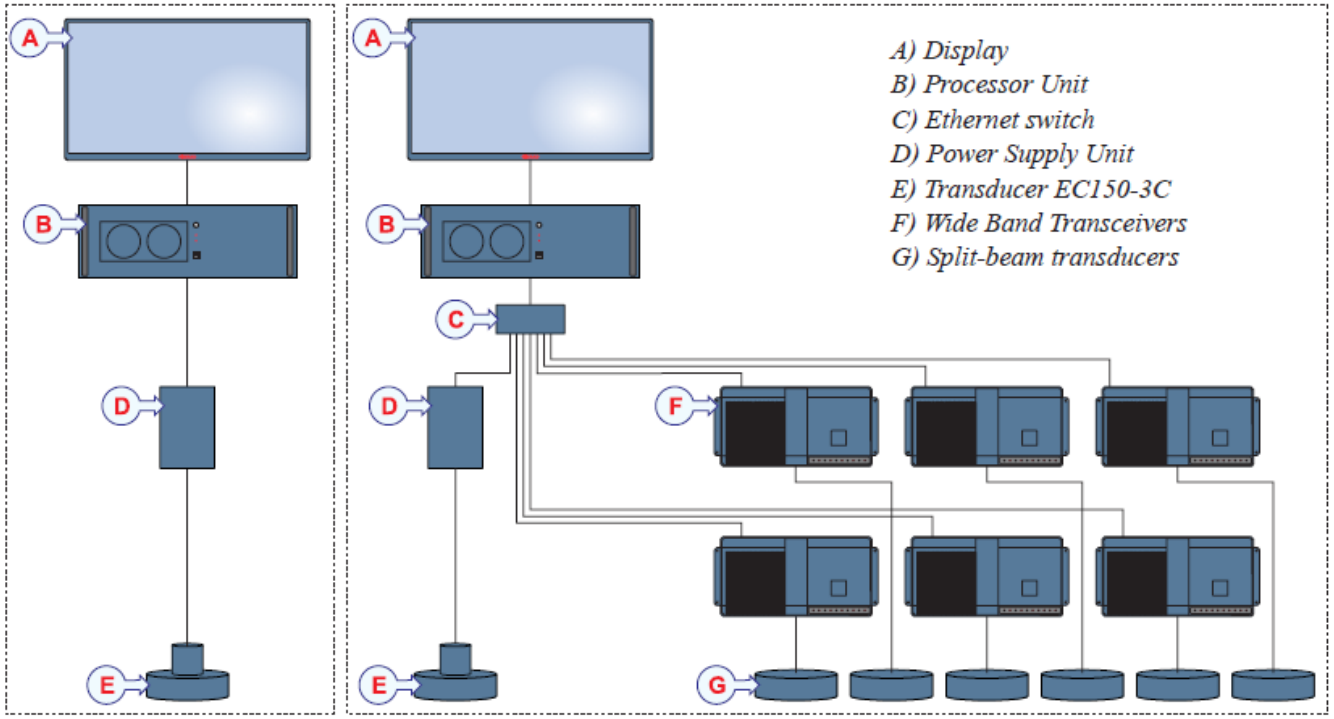
All in one rugged case = EK80 Portable

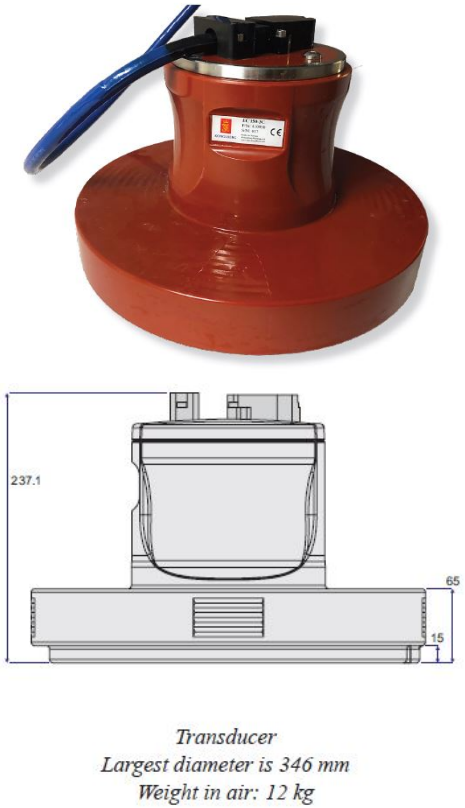


EK80 Echo sounder & ADCP



Transceiver & Transducer: EC150-3C



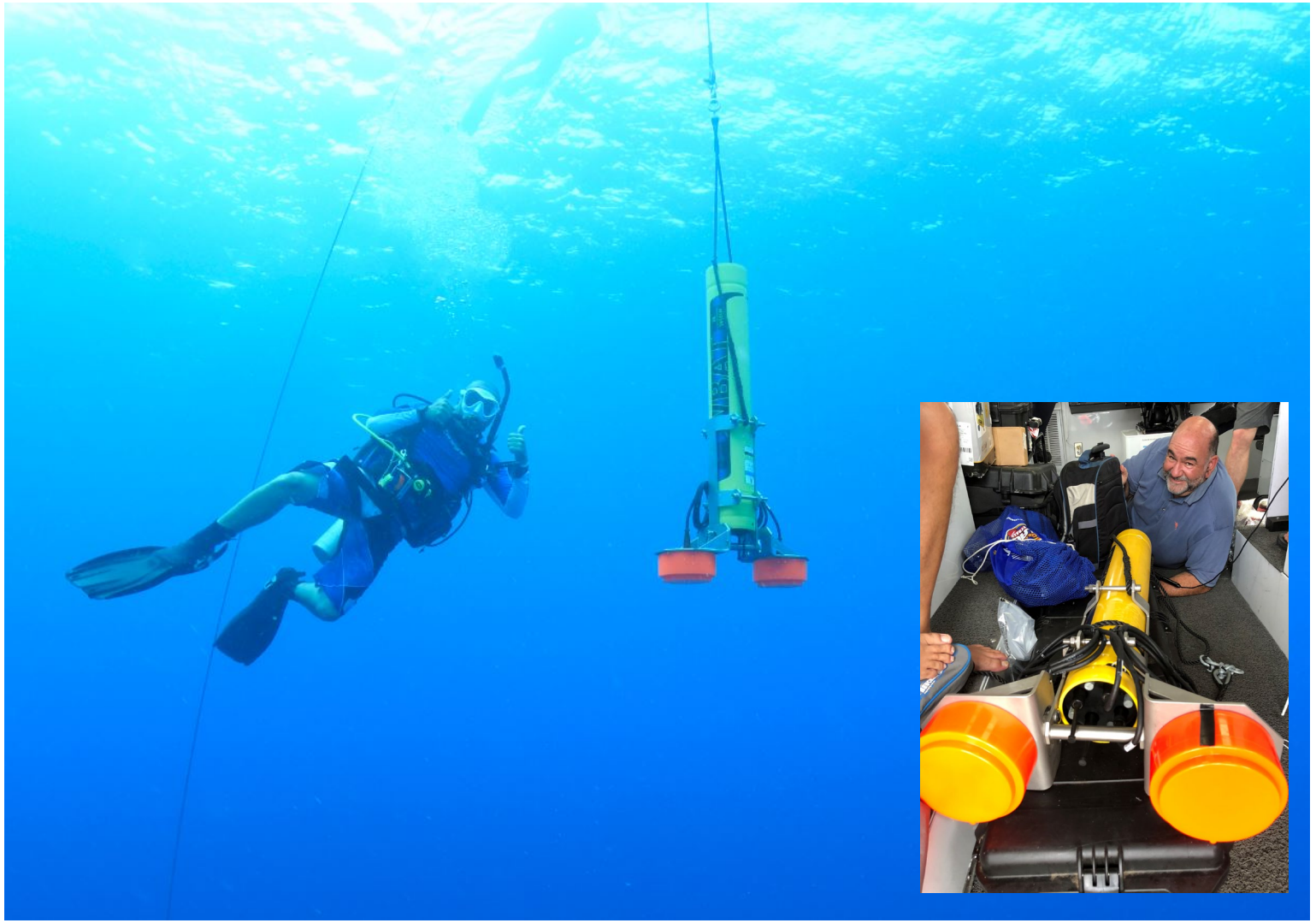


Transducer
Largest diameter is 346 mm
Weight in air: 12 kg

EK80 Echo sounder & ADCP

- General
  - Technology: Phased array
  - Nominal frequency: 150 kHz
  - Frequency range: 130 to 170 kHz
  - Dynamic range: 135 dB
- Echo sounder
  - Number of beams: 1 split beam
  - Beam width: 2.5 degrees @ 150 kHz
  - Pulse type: CW or FM
- ADCP
  - Number of beams: 4
  - Beam vertical tilt: 30 degrees
  - Beam width: 3 degrees @ 150 kHz
  - Pulse type: CW or FM
  - Cell size: 2 to 16 m
  - Max output sample interval: 40 µs
  - Max number of depth cells: Umlimited
  - Max range: > 400 m @ CW, 8 m cell size

Questions



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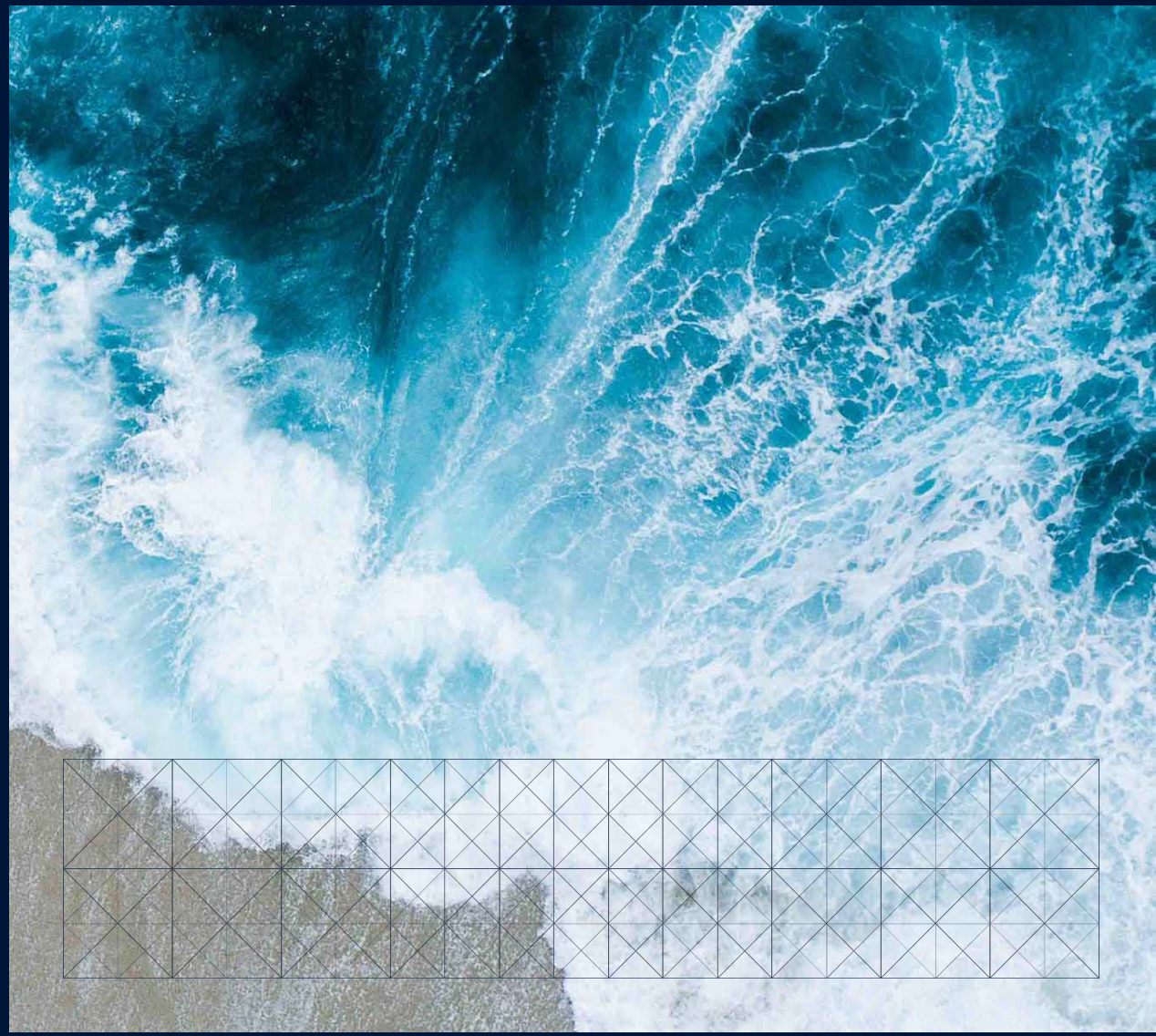
Scientific Research Vessels



Mark Amend

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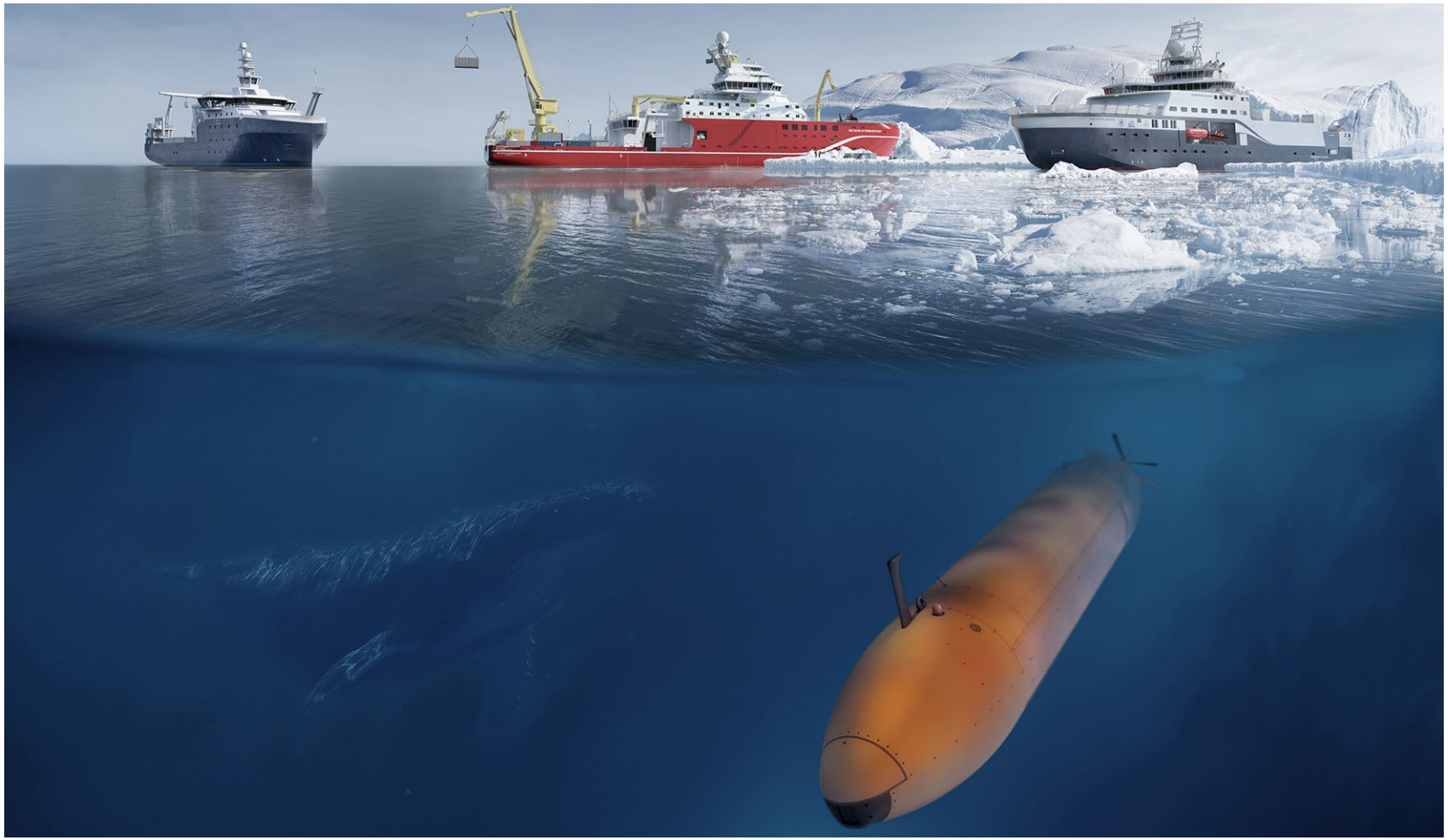
Integrated solutions from sensors to ship design

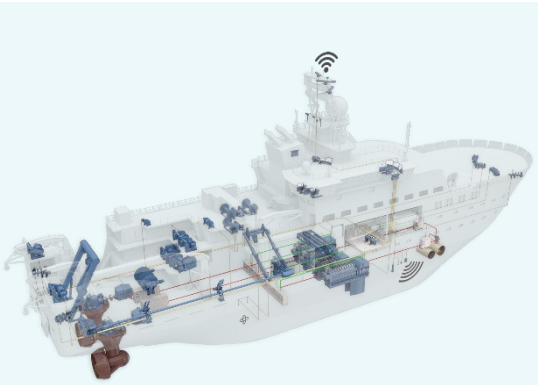


Our products and services

For Scientific Research vesels

SHIP DESIGN

More than 900 UT and NVC vessels are in operation all over the world – under the toughest conditions known. Our UT design is the benchmark of the offshore oil & gas industry.

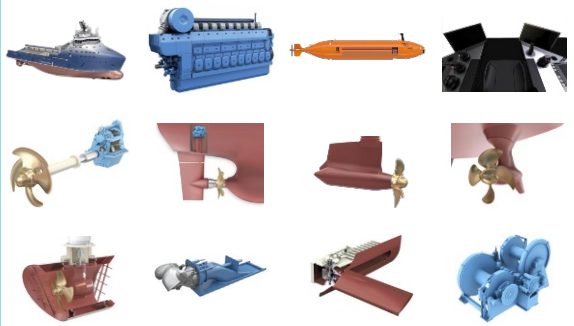


THE WIDEST RANGE OF PRODUCTS IN THE MARINE INDUSTRY

Our technology can be found in 1 out of 4 vessels in the registered world fleet, delivering mission critical marine power, control and propulsion systems and deck machinery.

SYSTEM INTEGRATION

From the fingertip controls of our advanced bridge systems, to the engine room, propulsion systems and on-deck equipment, we have unparalleled systems integration capability.



THROUGH-LIFE SERVICE AND SUPPORT

Global service network with more than 700 well-trained service engineers. Streamlined global spares distribution network and 24/7 technical support. Advanced customer training facilities in Norway, Singapore and Brazil.

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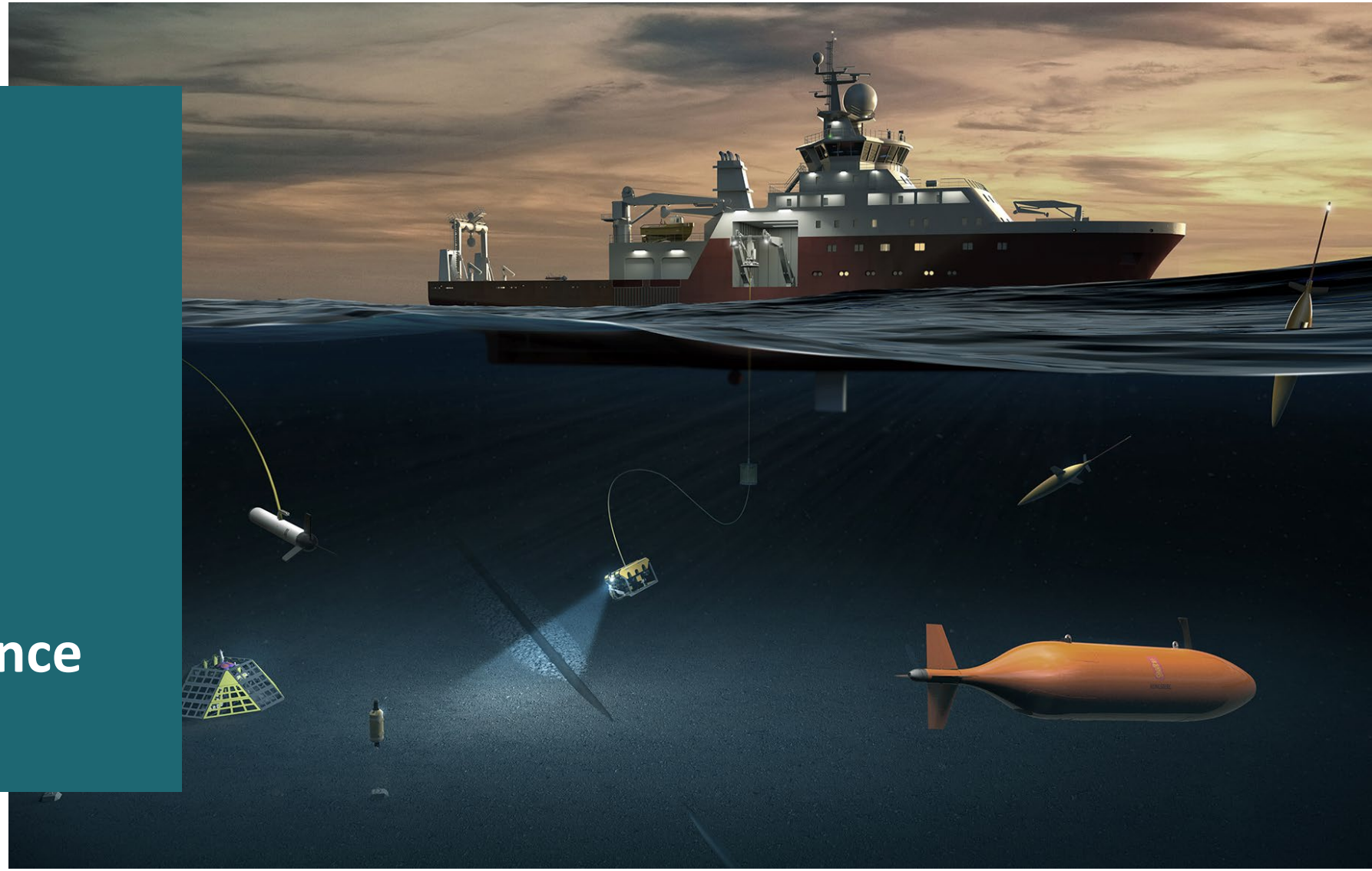
Underwater science



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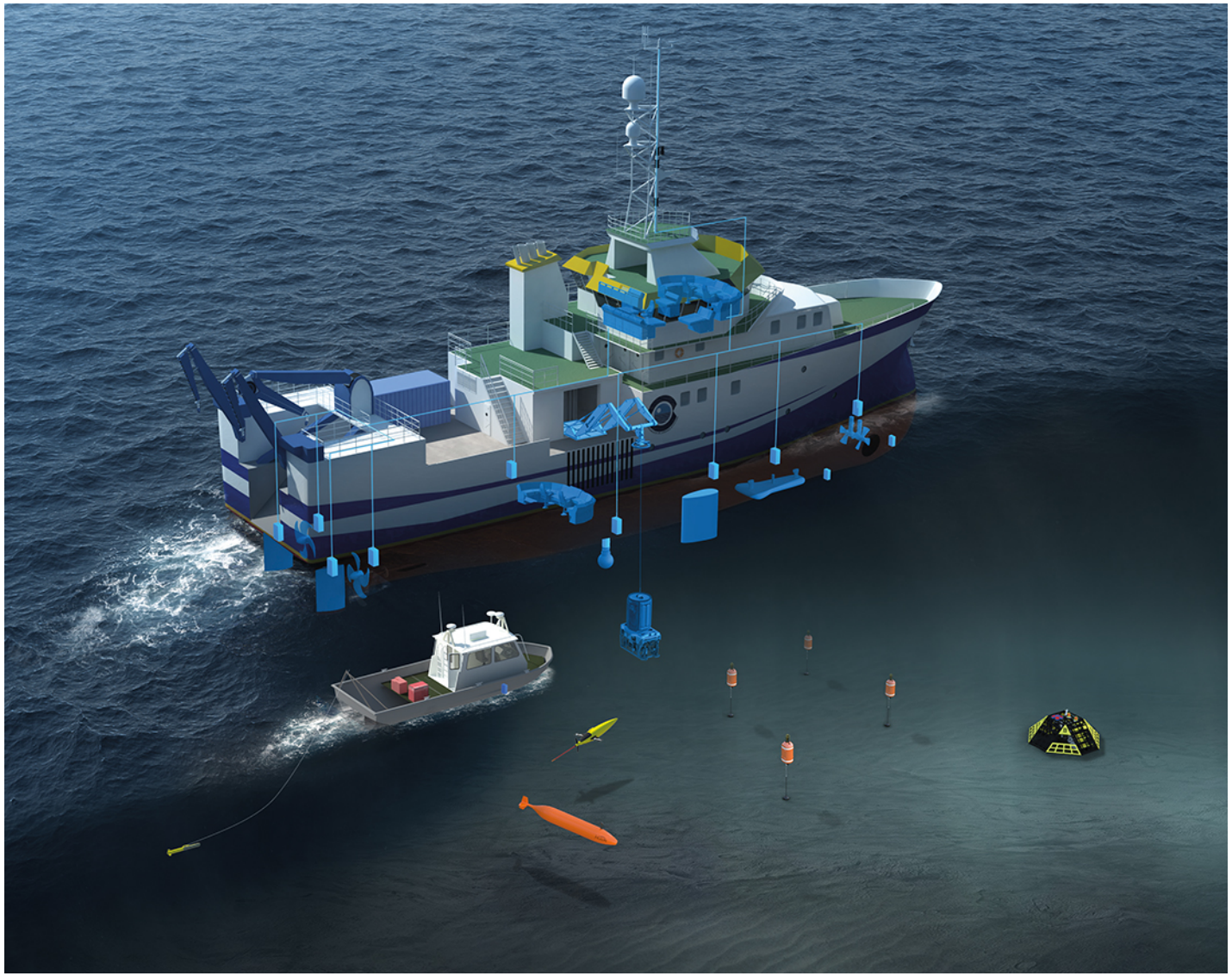
An holistic approach to scientific research

- Seamless information distribution across onboard systems, co-operating vessels and onshore
- Energy efficient handling solutions and power production systems, including storage and power generation
- Coordinated operation of navigation, machinery and deck handling system for efficient marine operation
- Synchronized world class sensors for observing and understanding the marine ecosystem



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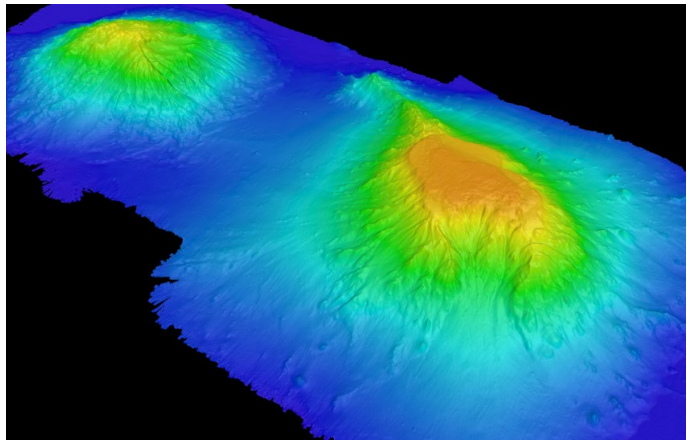
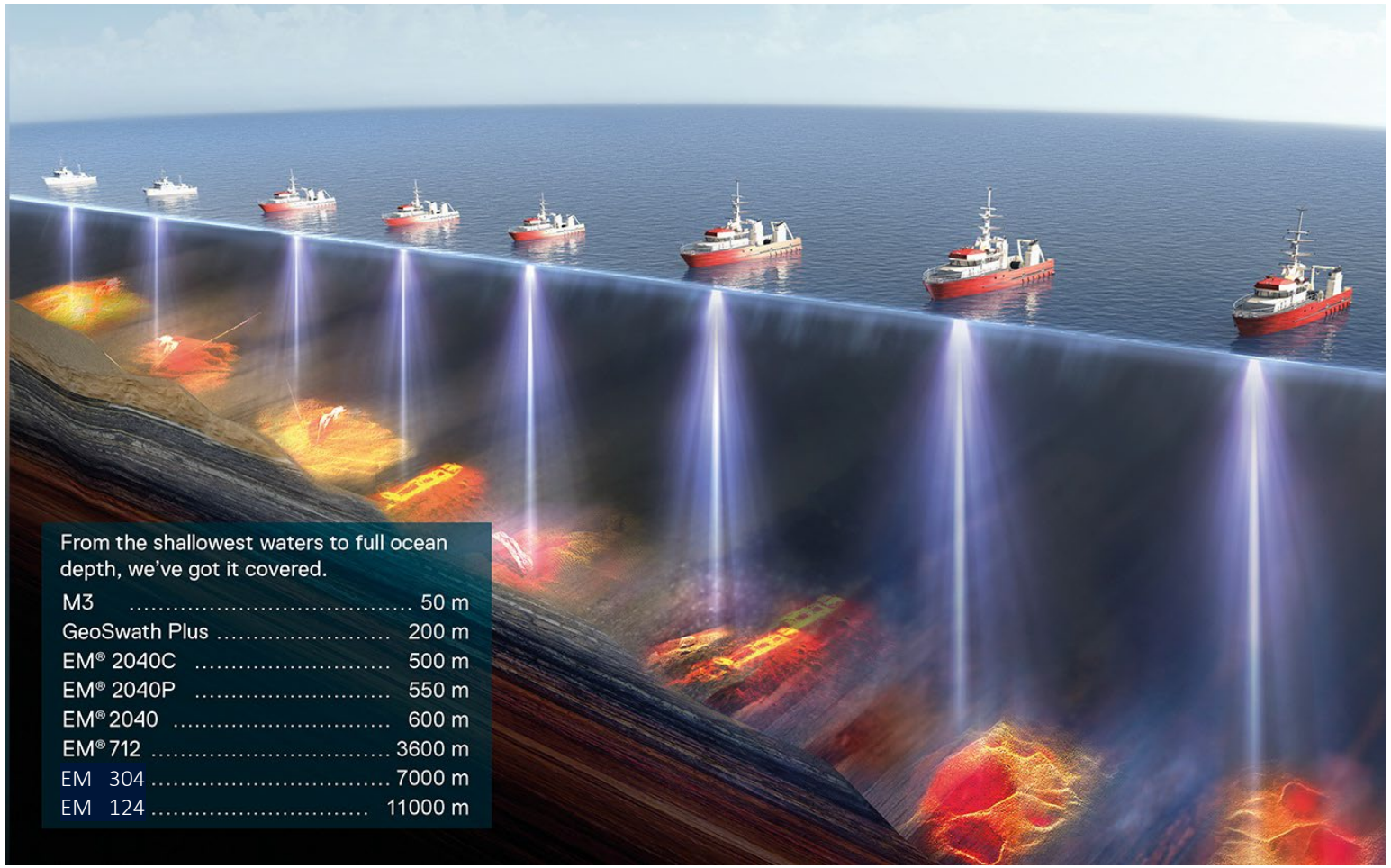
Acoustics - Multibeam Echo Sounders

High resolution bathymetry
for mapping purposes





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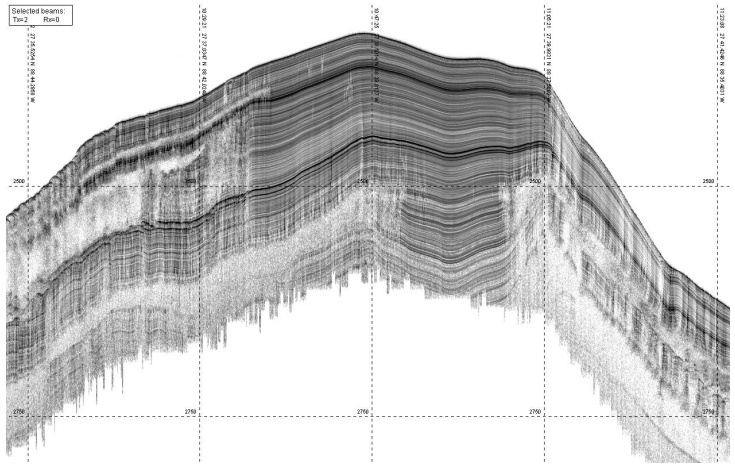
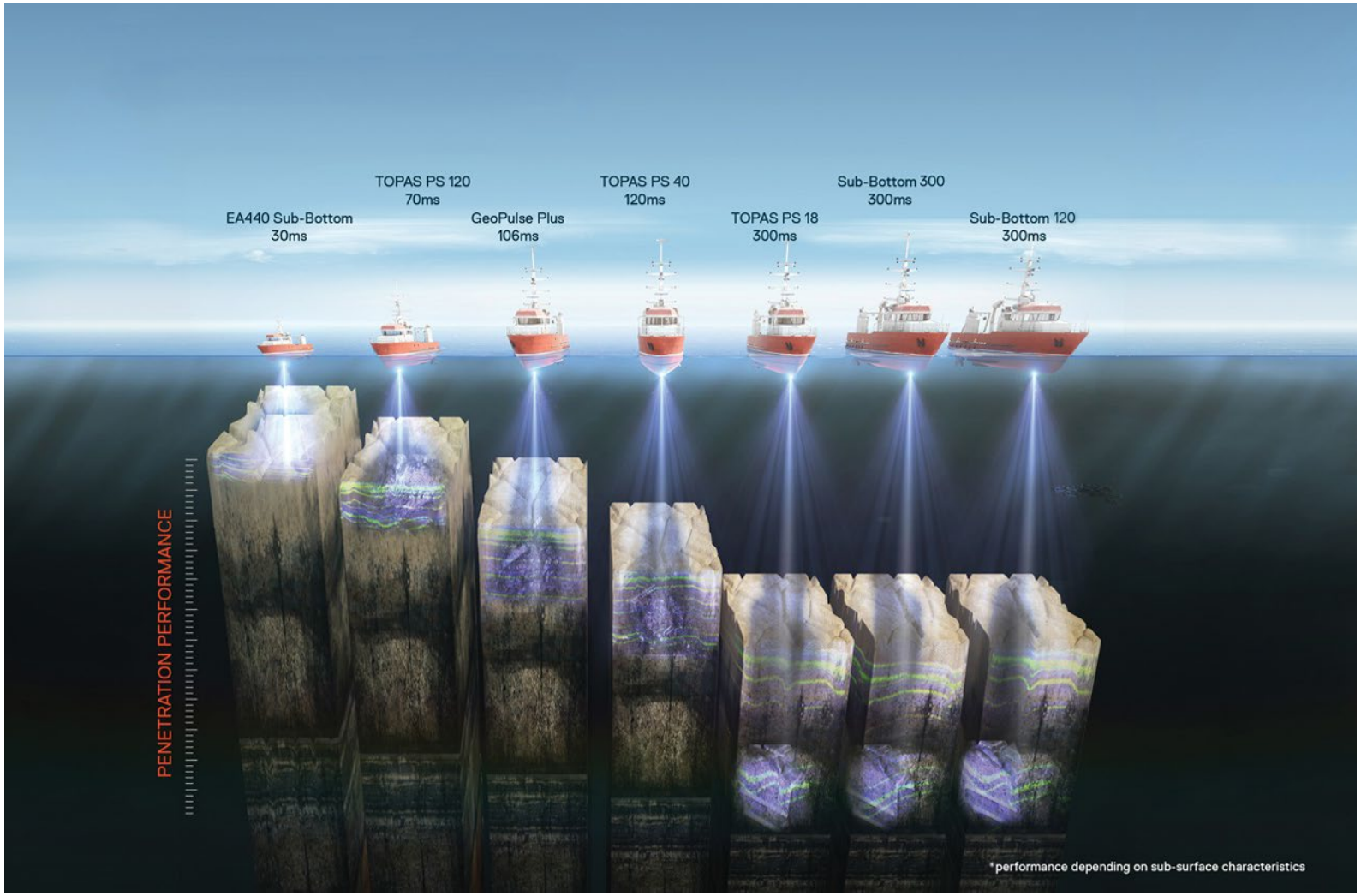
Acoustics – Sub-bottom Profilers

Geology, light penetration





UNOLS – University-National Oceanographic Laboratory System

Program Office located at Univ. Washington, Seattle

- In shipyard: EM 124; EM 712; EK 80 ***Roger Revelle*** *(Scripps)*
- EM 122, EM 712, HiPAP 501; EK80; Seapath 330 ***Sally Ride*** *(Scripps)*
- EM 122 EK 80 ***Atlantis*** *(WHOI)*
- EM 122, EM 712, EK80 ***Neil Armstrong*** *(WHOI)*
  - *NEW:* ***AUV Sentry, ROV Jason, HOV Alvin*** *EM 2040 (WHOI)*
- EM 122, EM 710 ***Kilo Moana*** *(Univ Hawaii)*
- EM 122, Seapath ***Marcus Langseth*** *(Columbia)*
- EM 122 (icebreaker) ***Nathaniel B. Palmer*** *(US Antarctic Program, Choest)*
- EM 122 (icebreaker) ***Healy*** *(USCG / Scripps)*
- EM 302 ***Thomas G. Thompson*** *(Univ Washington)*
- EM 302 (icebreaker); EM 710; TOPAS PS18 EK80; Seapath ***Sikuliaq*** *(Univ Alaska)*

Regional Class Research Vessel (RCRV) Project

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Detail Design and Construction Awarded to Gulf Island Shipyard

- RCRV 1: **R / V *Taani*** Oregon State Univ.
- RCRV 2: **R / V *Resolution*** University of Rhode Island (URI), Univ New Hampshire (UNH), Woods Hole Oc. Inst. (WHOI) consortium
- RCRV 3: **R / V *Gilbert R. Mason*** Gulf – Caribbean Oceanographic Consortium, Univ Southern Miss, LUMCON, Bermuda Inst Ocean.

Integrated Acoustic Systems SSV:

- EM 304 0.5 x 1
- TOPAS PS18
- EM 2040-07
- EK 80 18/38/70/120/200
- Teledyne ADCP 38/70/120
- Knudsen 3610 Chirp
- 2x Seapath 380-MGC
- Hydrophones / noise monitoring system
- Video wall / matrix
- Rack units / UPS

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Seabed 2030 Initiative

Now at 19%

We can all contribute

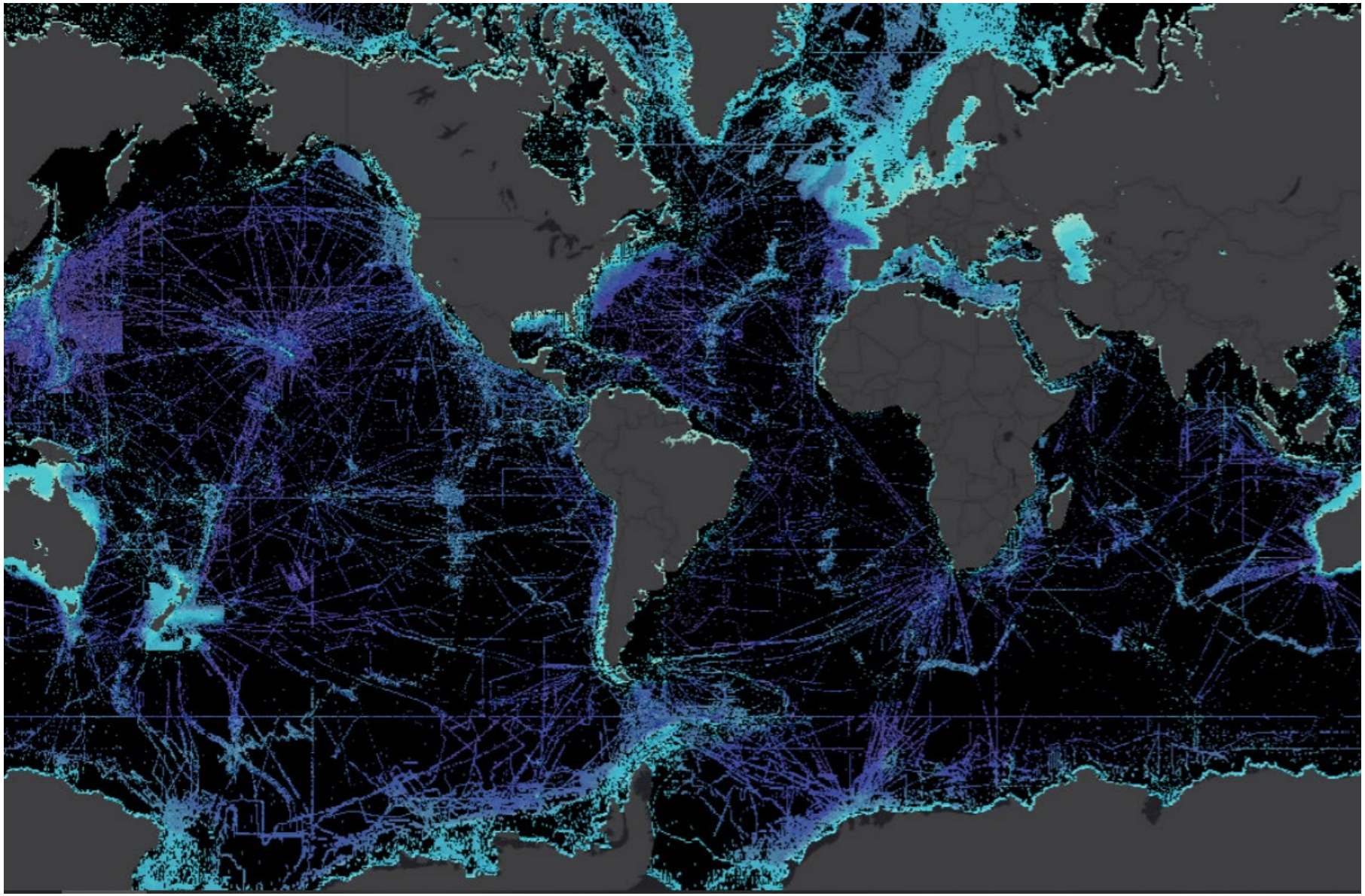

Image credit (2019) *Ferrini, V., Dorschel, B., Seabed 2030: Progress and Achievements., The Nippon Foundation – GEBCO Seabed 2030 Project, From Vision to Action.*

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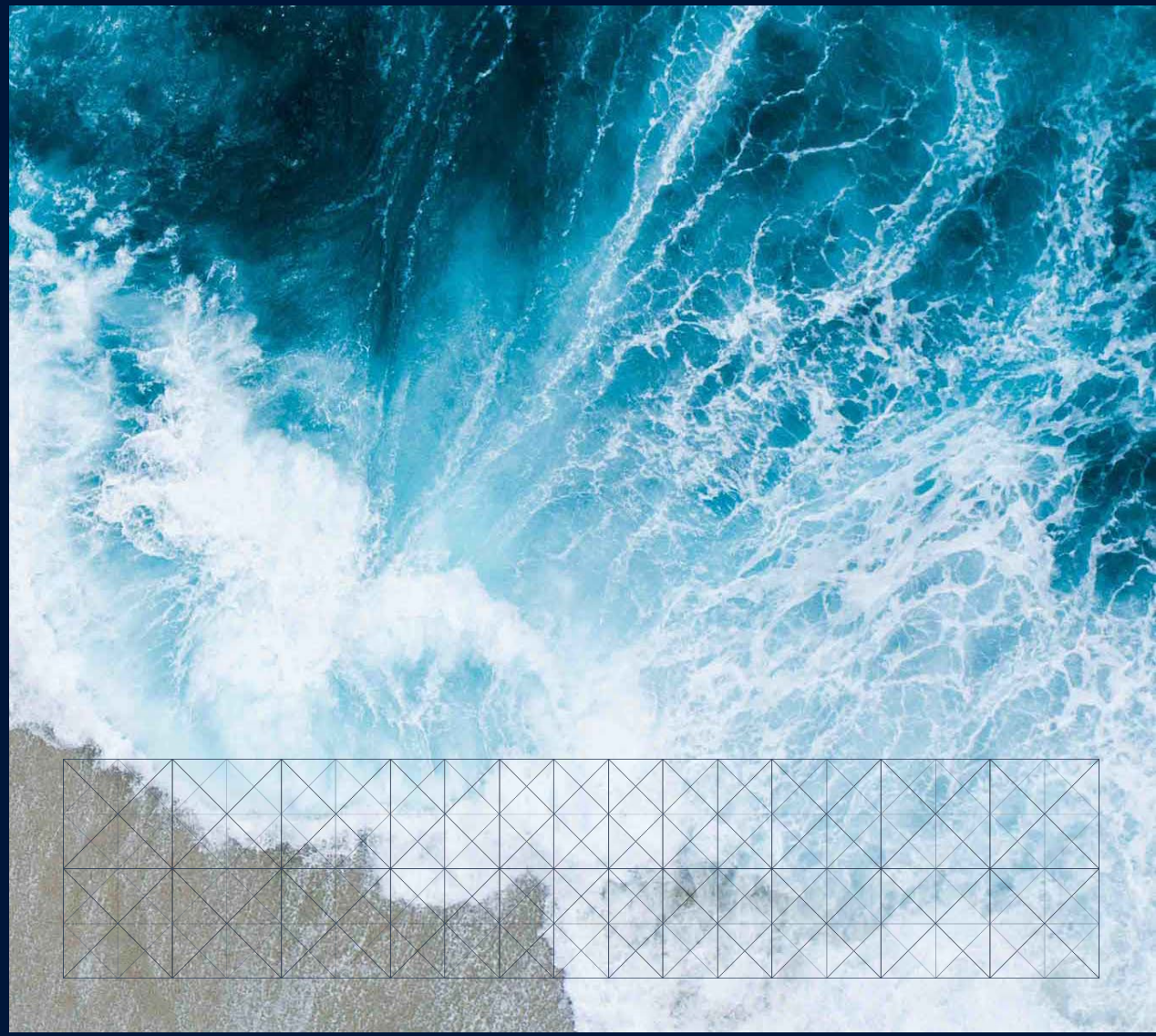
Kongsberg Positioning

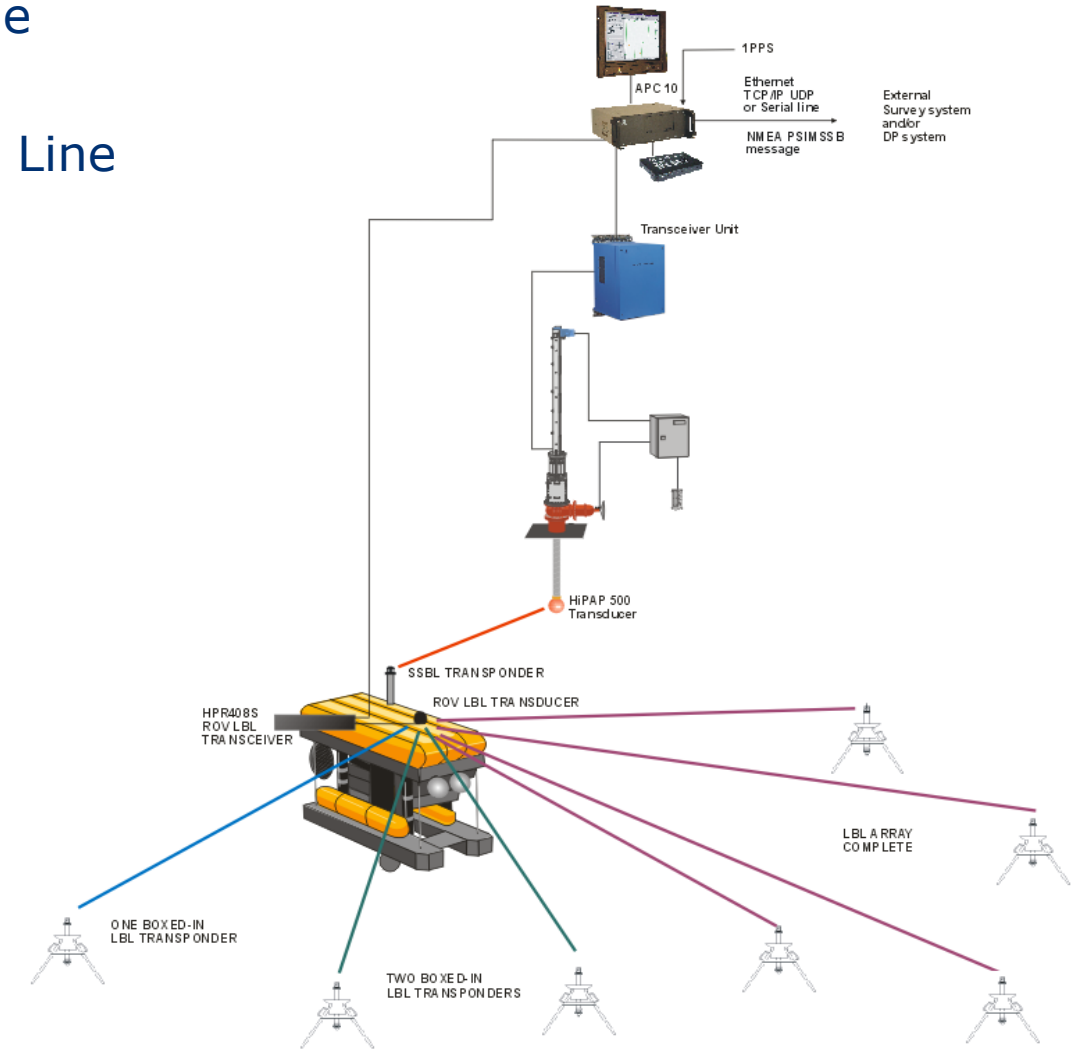


Brett White

Positioning principles overview

- SSBL Super Short Base Line
- LBL Long Base Line
- MULBL Multi User Long Base Line
- SSBL and 2 x LBL range
- SSBL and 1 x LBL range

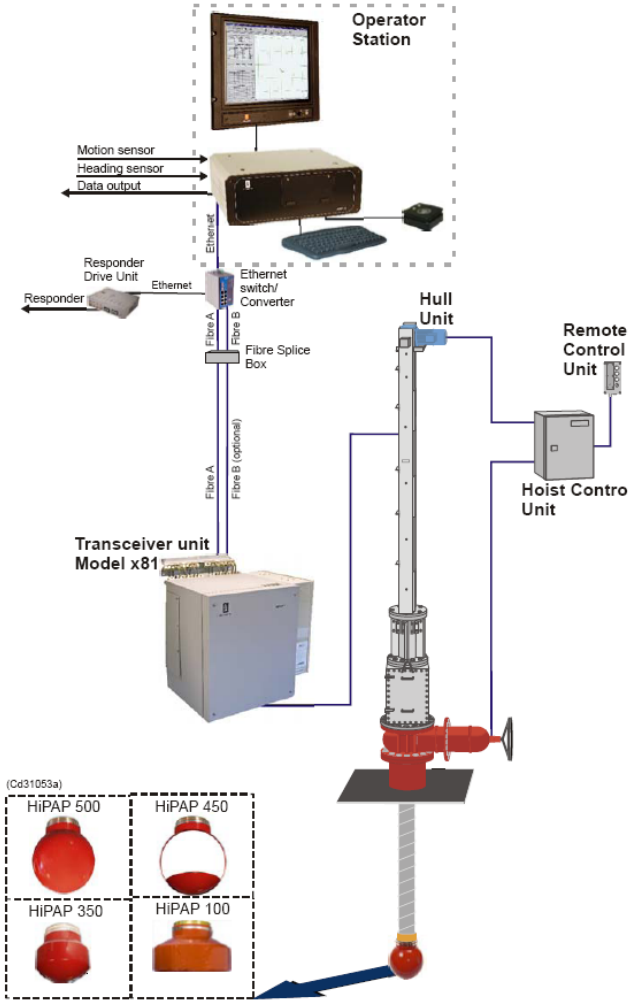
All principles can be
used as acoustic aid to the
HAIN - Hydroacoustic Aided
Inertial Navigation system

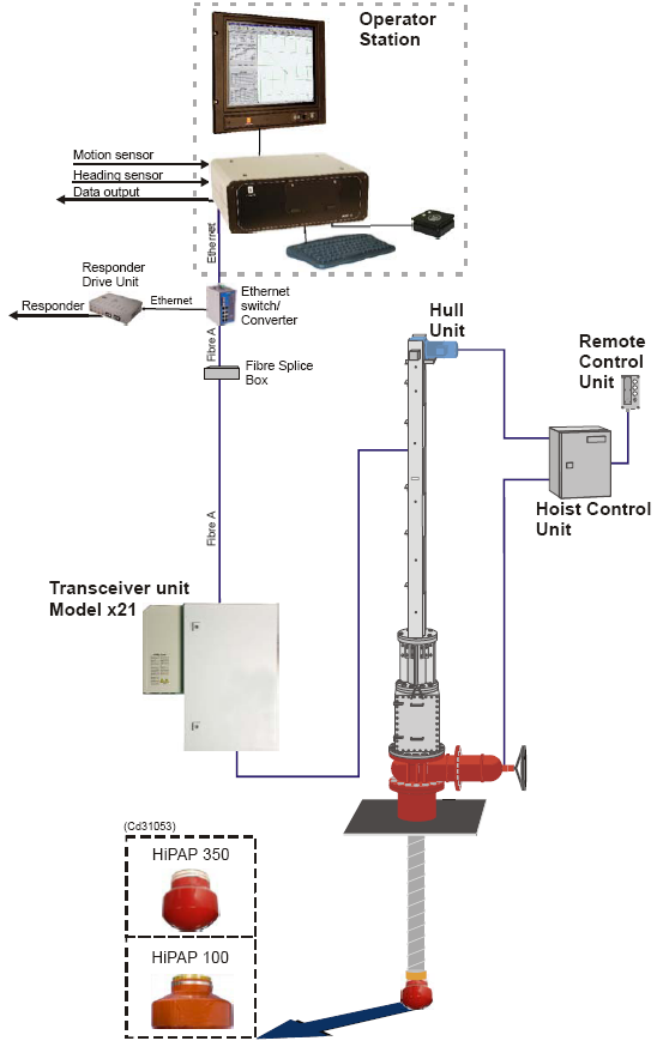


The HiPAP® family - from surface to full ocean depth

KONGSBERG

- Operator Station
- Transceiver
- Hull Unit
  - HL 2180
  - HL 3770
  - HL 4570
  - HL 6120
- Transducer
  - HiPAP® 100
  - HiPAP® 350
  - HiPAP® 450
  - HiPAP® 500

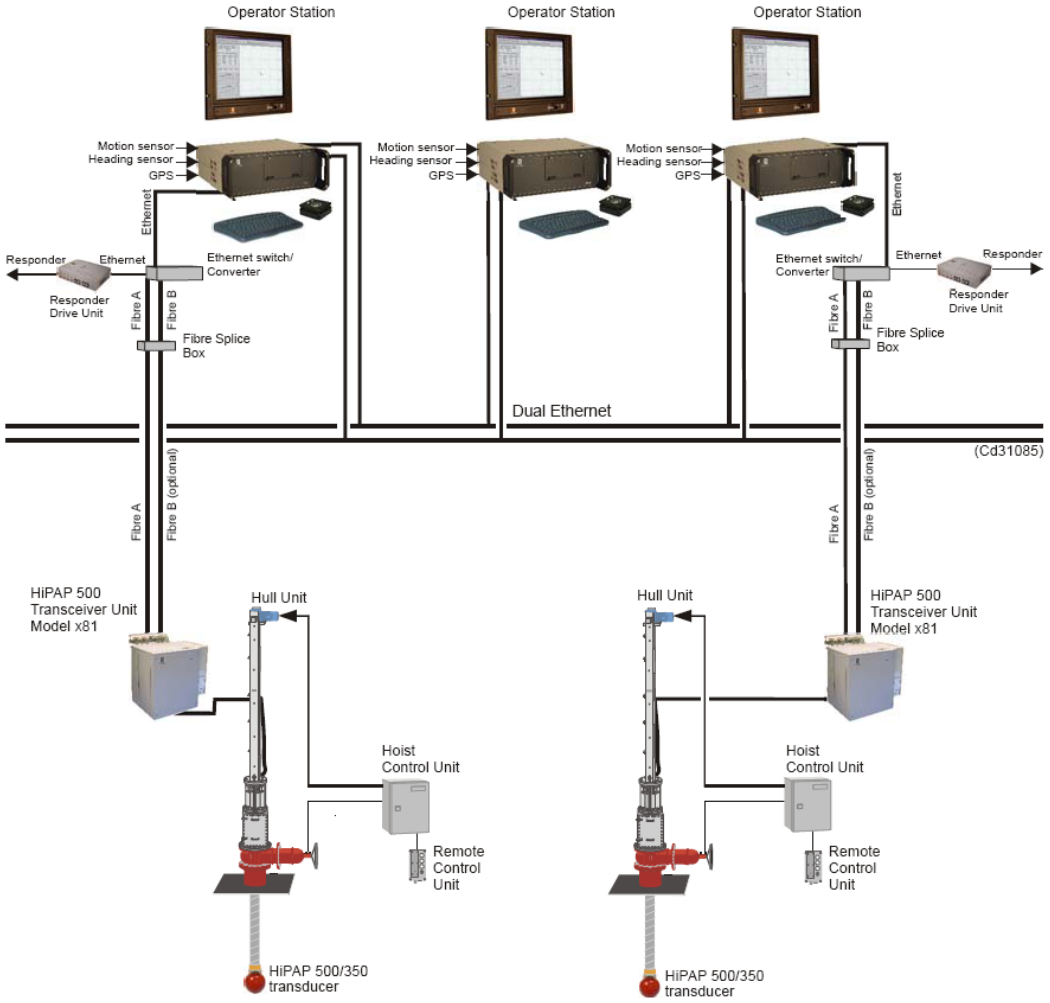




The HiPAP® family - from surface to full ocean depth

KONGSBERG

- Alternative operator console
- Redundant system



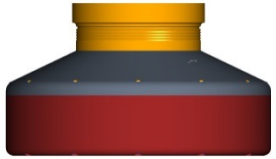
The HiPAP® family - from surface to full ocean depth

- HiPAP® 502

- HiPAP® 352

- HiPAP® 452

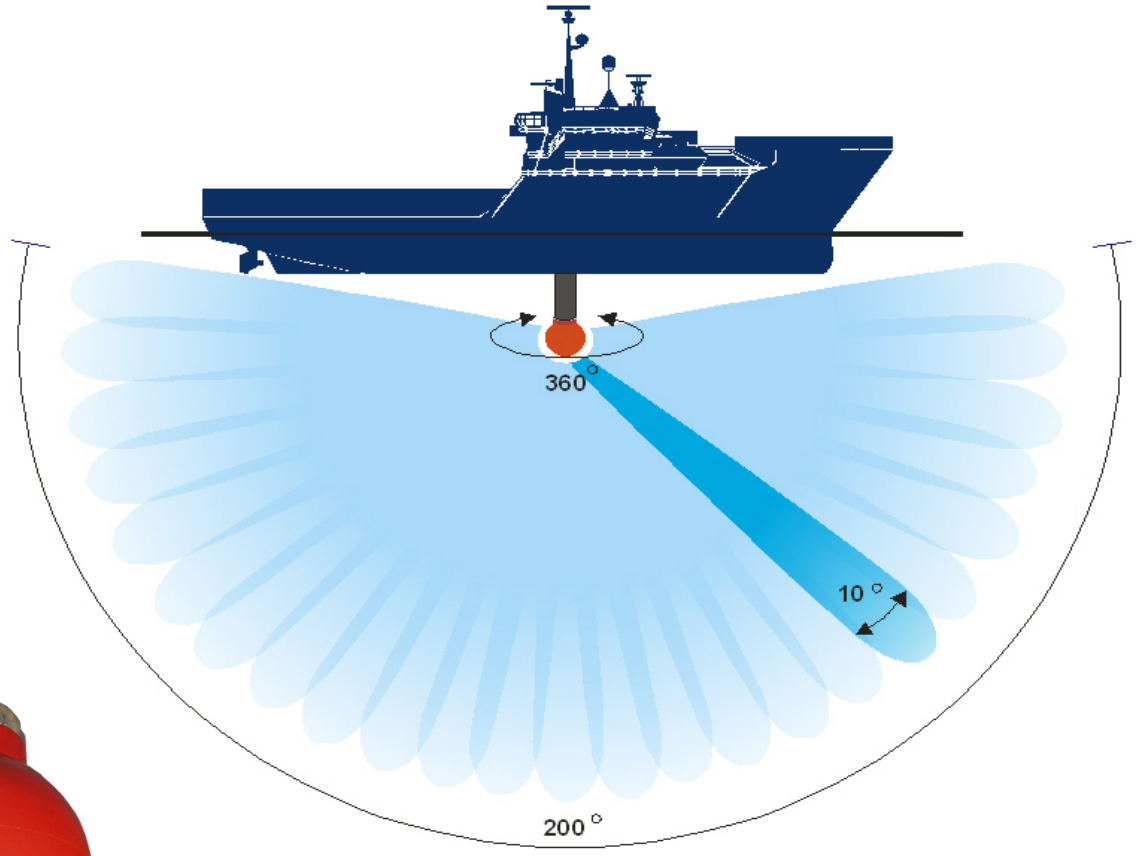
- HiPAP® 102



- HiPAP® 352P Portable

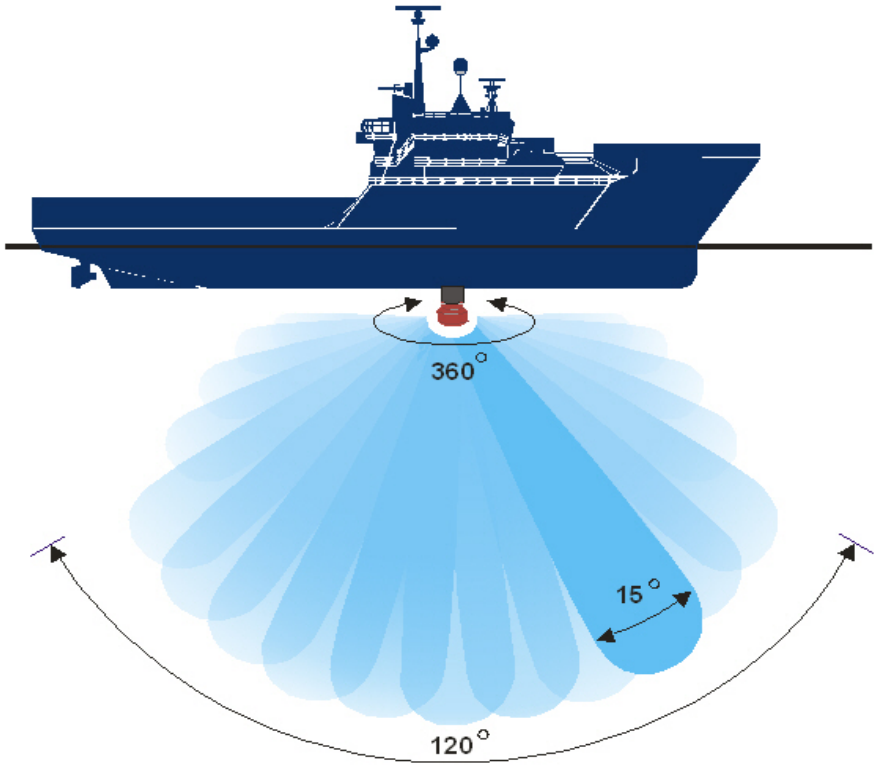
HiPAP® 502

- Operating area below vessel
  - ± 100°
- Narrow receiver beam
  - ± 5°
  - Dynamic beamforming
- Typical operating range
  - ~ 5000m
- Range detection accuracy
  - ~ 0.02m
- Angle accuracy
  - ≤ 0.06º ≤ 0.2%



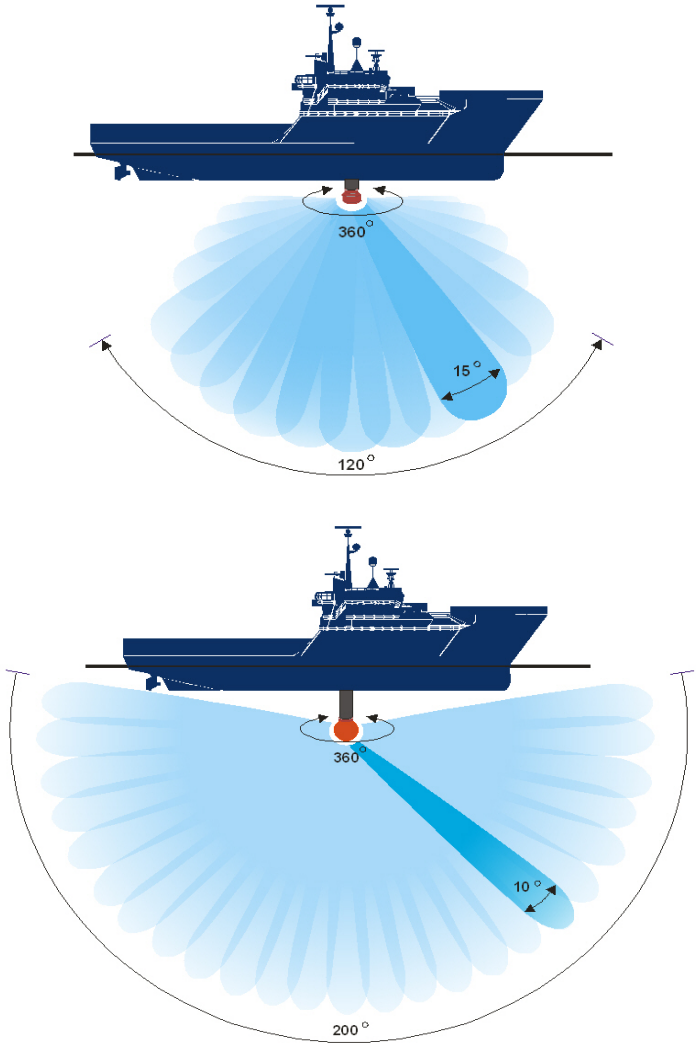
HiPAP® 352

- Operating area below vessel
  - ± 60°
- Narrow receiver beam
  - ± 7.5°
  - Dynamic beamforming
- Typical operating range
  - ~ 5000m
- Range detection accuracy
  - ~ 0.02m
- Angle accuracy
  - ≤ 0.10º ≤ 0.2%



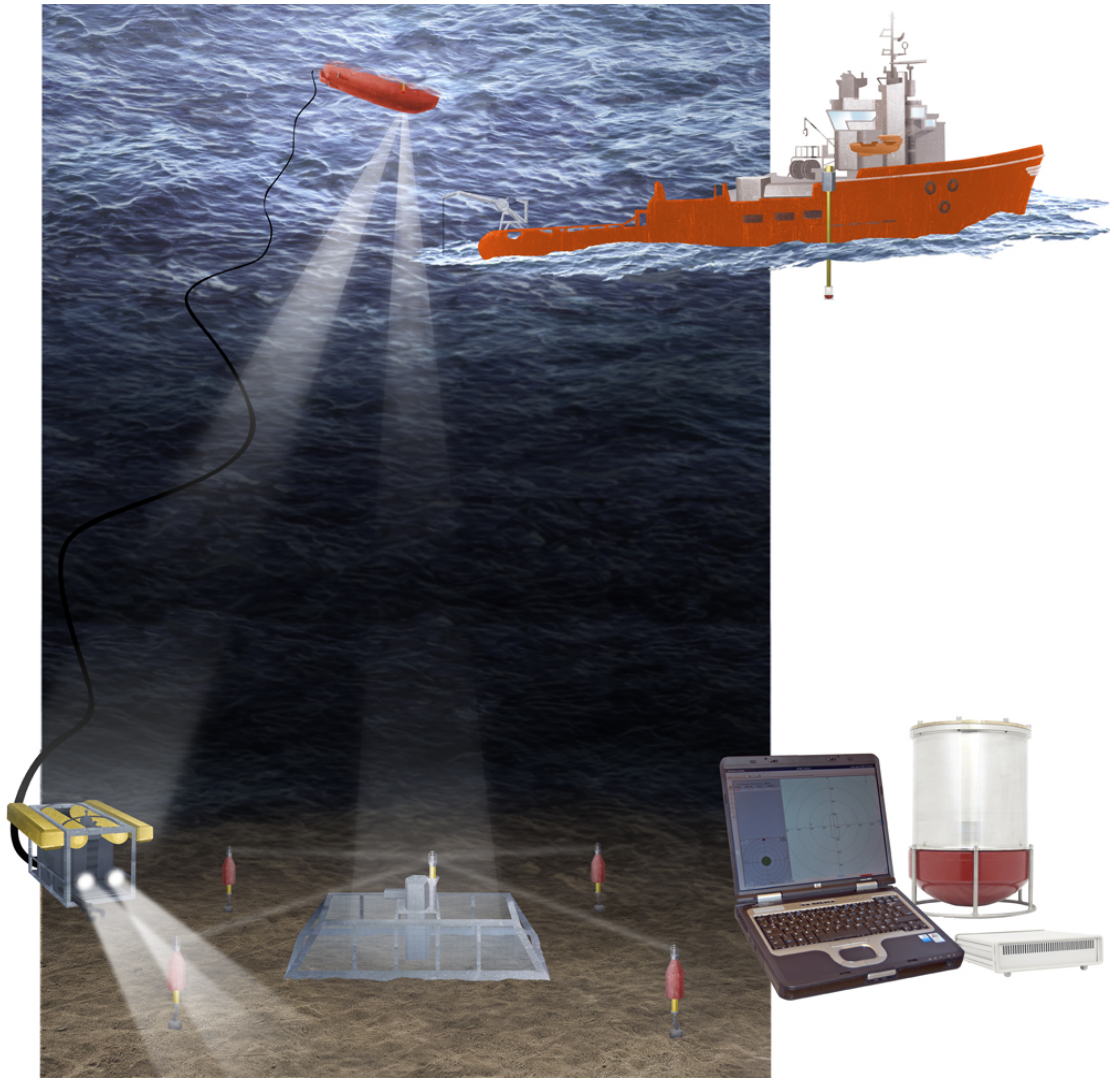
HiPAP® 452

- Reduced HiPAP®500 performance
- Easy to upgrade to HiPAP®500 performance
  - Software and Tx/Rx boards
- Operating area below vessel
  - ± 60° upgradeable to ± 100°
- Narrow receiver beam
  - ± 7.5° upgradeable to ± 5°
  - Dynamic beamforming
- Typical operating range
  - ~ 5000m
- Angle accuracy
  - ≤ 0.10º ≤ 0.3% upgradeable to
  - ≤ 0.06º ≤ 0.2%



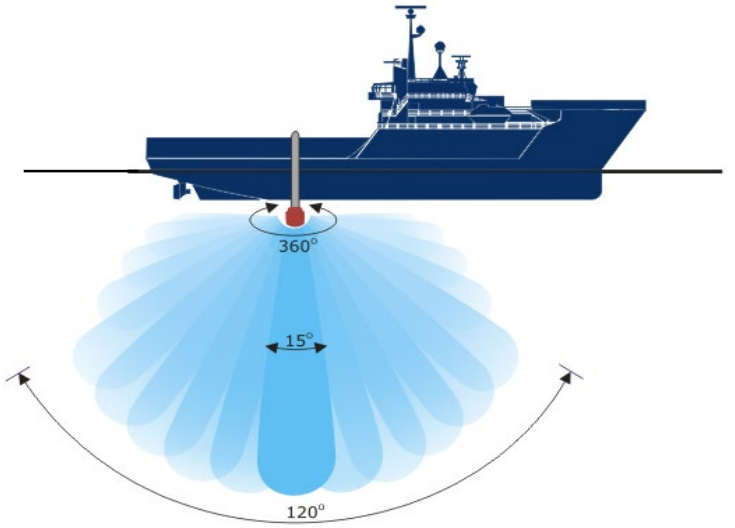
HiPAP® 352P - Portable

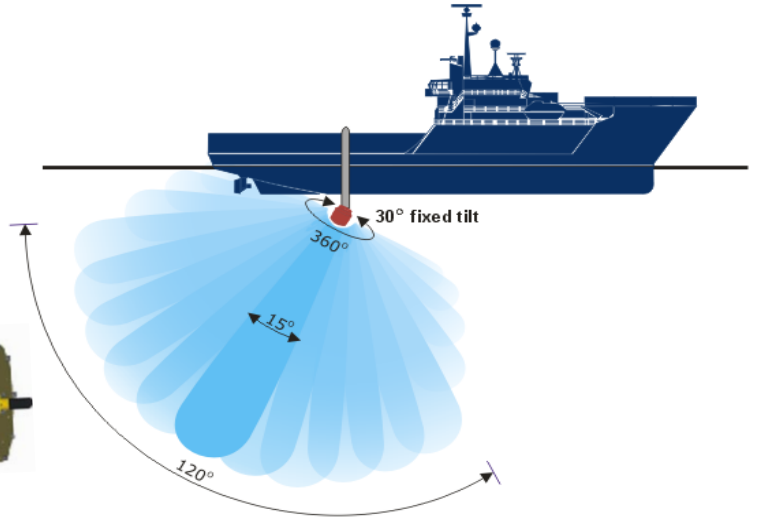
- Operator station
  - Lap-top computer
  - Gyro data input
  - dGPS data input
- Interface unit
  - Responder output
  - Power supply
  - Network
- Transducer cable
  - 50m cable length
- Transducer
  - HiPAP® 350
  - Built-in roll and pitch sensor

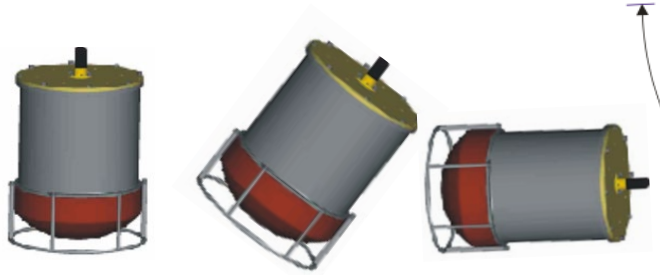


HiPAP® 352P - Portable

- Operating area below vessel
  - ± 60°
  - Can be tilted to change operating area
- Narrow receiver beam
  - ± 7.5°
  - Dynamic beamforming
- Typical operating range
  - ~ 5000m
- Range detection accuracy
  - ~ 0.02m
- Angle accuracy
  - ≤ 0.10º ≤ 0.2%

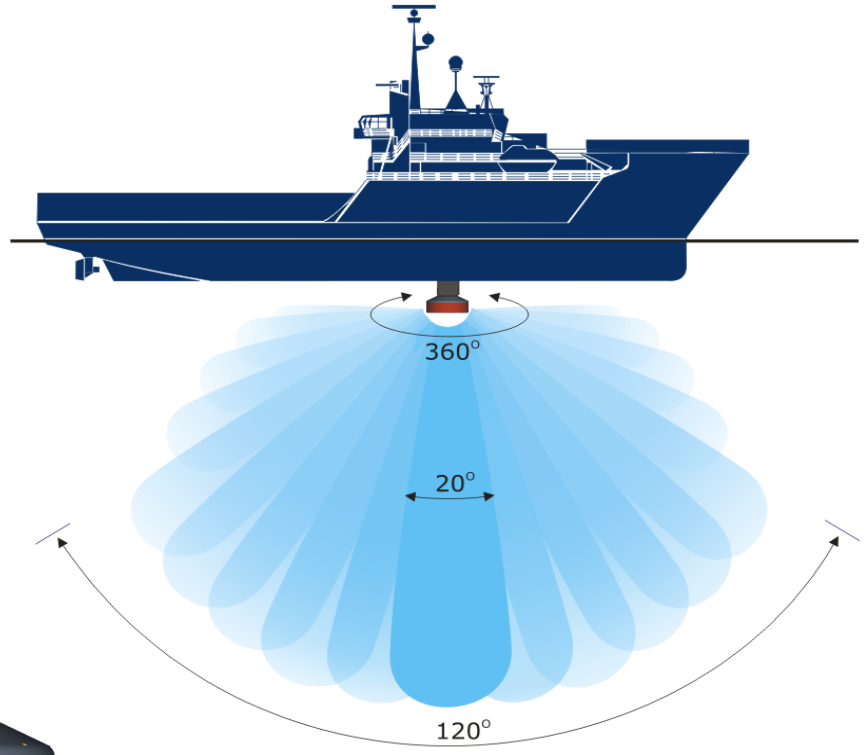


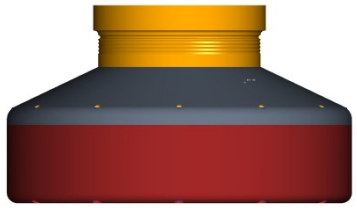




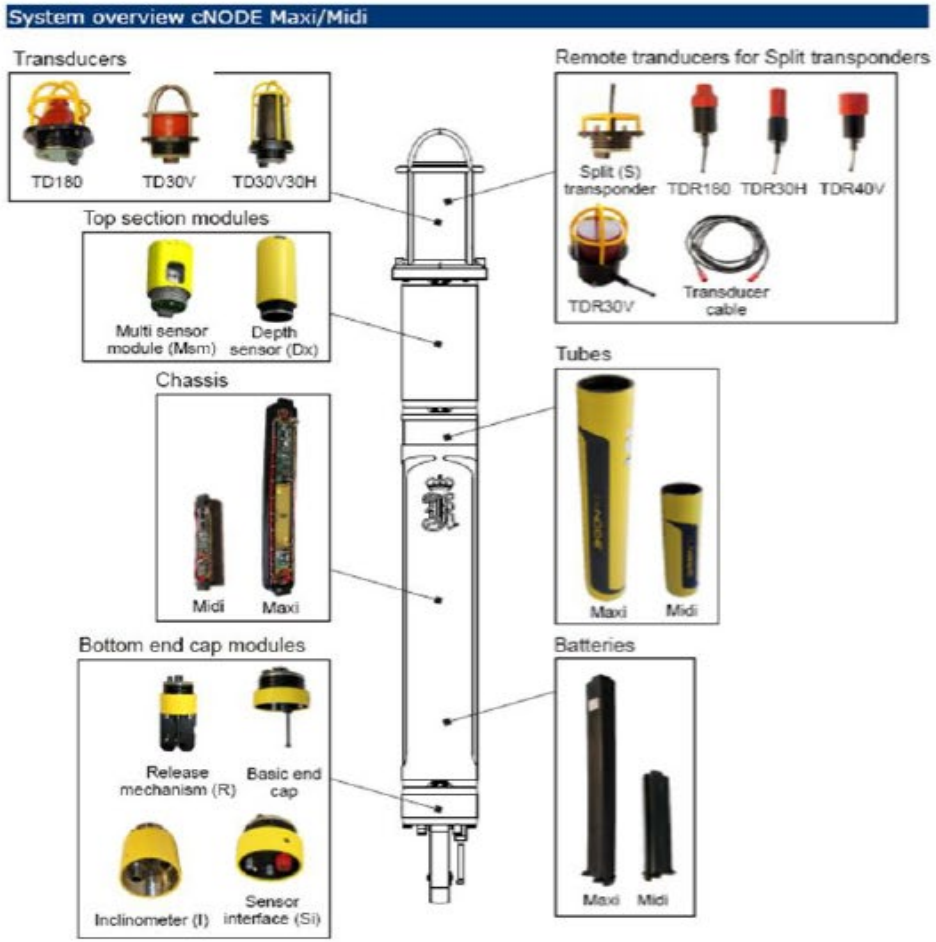
HiPAP® 102

- Operating area below vessel
  - ± 60°
  - Can be tilted to change operating area
- Narrow receiver beam
  - ± 7.5°
  - Dynamic beamforming
- Typical operating range
  - ~ 10000m
- Range detection accuracy
  - ~ 0.02m
- Angle accuracy
  - ≤ 0.14º ≤ 0.2%





cNODE® - Modular design



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A new small cNODE transponder

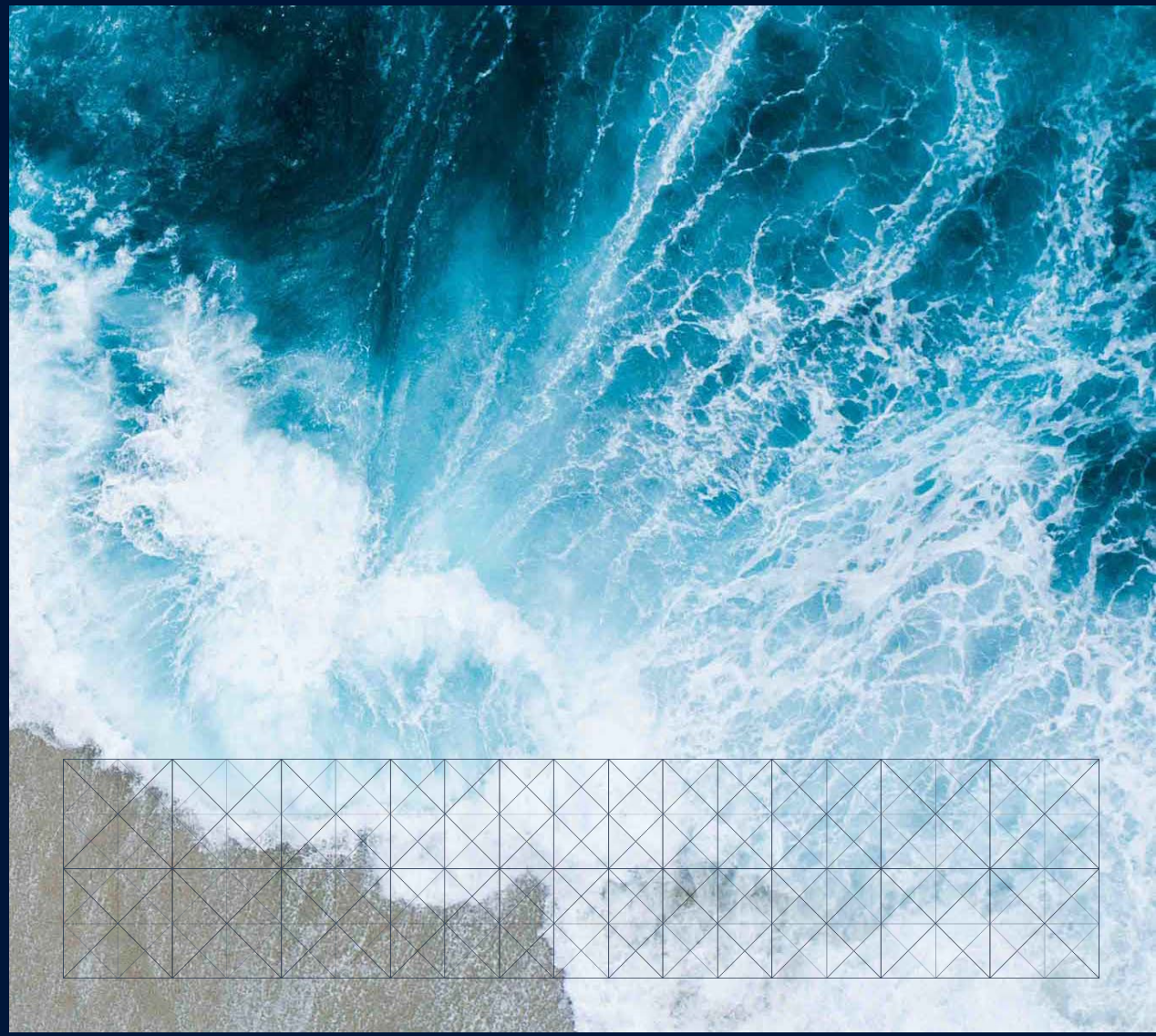
- MST replacement
- ROV positioning

- Acoustics: Cymbal and FSK
- Functionality: SSBL, Responder, LBL, Telemetry
- External power: 24V, 2A
- Depth rating: 4000m

- Transducers: TD180, TD40V, TD30H

KONGSBERG

Kongsberg Navigation - Sunstone



Øyvind Hegrenæs, Ph.D.

Kongsberg Maritime Aided INS

Key Points

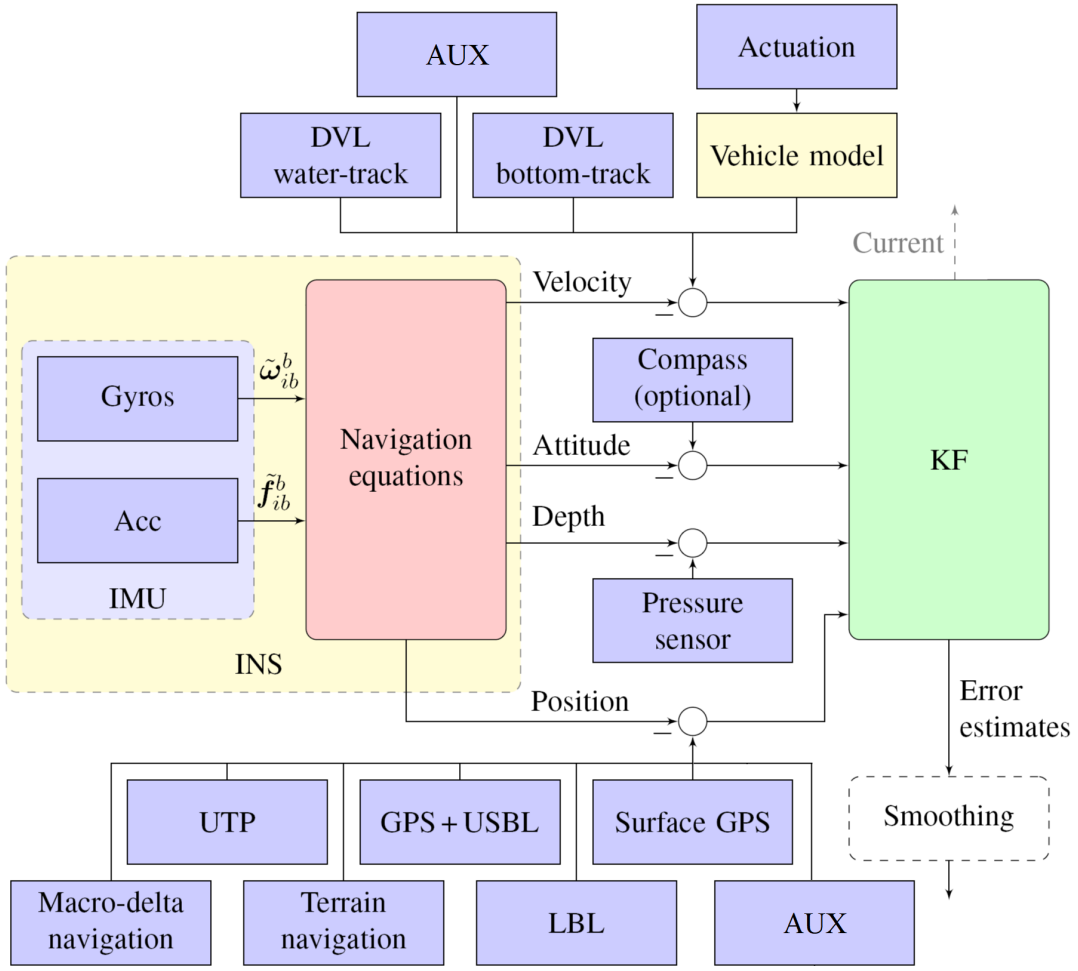
- KM/FFI proprietary. Designed for AUV and marine applications. World class navigation performance
- Well proven and robust technology
  - Commercial operations since 1997
  - Military operations since 2001. In NATO exercises since 2003
  - Been used to cover >> 1 000 000 line-km at 2 m/s
  - Used in Kongsberg AUVs, USVs, etc
- Significant continued investment and development together with FFI
- Full suite of navigation simulation and post-processing tools
- Advanced clock/time system and acoustic triggering regime
- Interface to KM payload processor and sonars

KM INS Aiding Sensors and Data Fusion

In-situ:
Sunstone/NavP

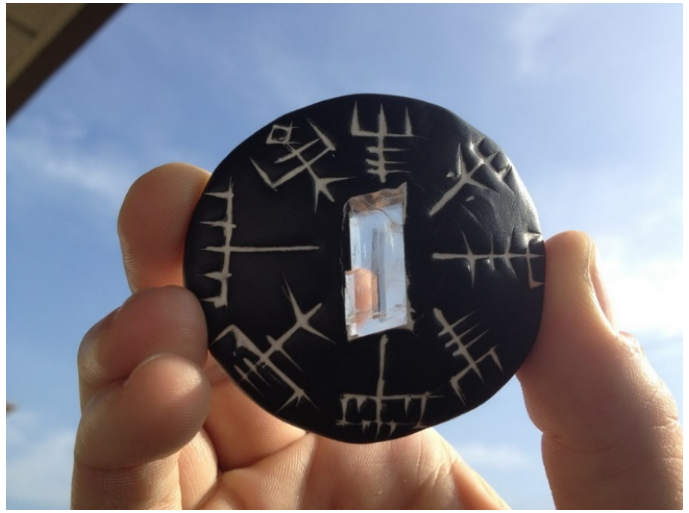
Post-processing:
Sunstone Postea
(building on NavLab experience)

Most code, algorithms and developments are shared



Sunstone and Sunstone Postea

"Kongsberg INS in a box"



"Could be one of the secrets behind the Vikings' reputation as remarkable seafarers whose prowess at heading into unexplored water means they may have beaten Christopher Columbus as the first European visitors to America by hundreds of years"

Source: http://www.independent.co.uk/ (2013)

Integrated in e.g. HUGIN and REMUS AUVs
Available to external parties for selected projects

Navigation + trigger control + time server

Sunstone

Features

- Small form-factor processing unit for real-time inertial navigation
- Renavigation and post-processing using Sunstone Postea
- Builds on two decades of extensive development and experience with NavP and NavLab
- Interface to a wide range of IMUs and aiding sensors and techniques, including 3rd party inputs
- Trigger synchronization control and time server functionality
- Opto-isolated inputs and outputs

Technical Specifications for Sunstone

- Power options: 5V and 8.5-14V
- Dimensions with housing: 124.5mm x 100mm x 34mm
- Master clock and time server: NTP input and output, 1 PPS inputs and outputs
- Master clock drift < 0.1 PPM when subsea (without external time sync)
- Gbit LAN, multiple configurable RS232/RS422/RS485/TTL, SDLC
- Trigger outputs (for e.g. acoustic synchronization): Multiple configurable RS232/RS422/TTL/relay
- Various data logging options

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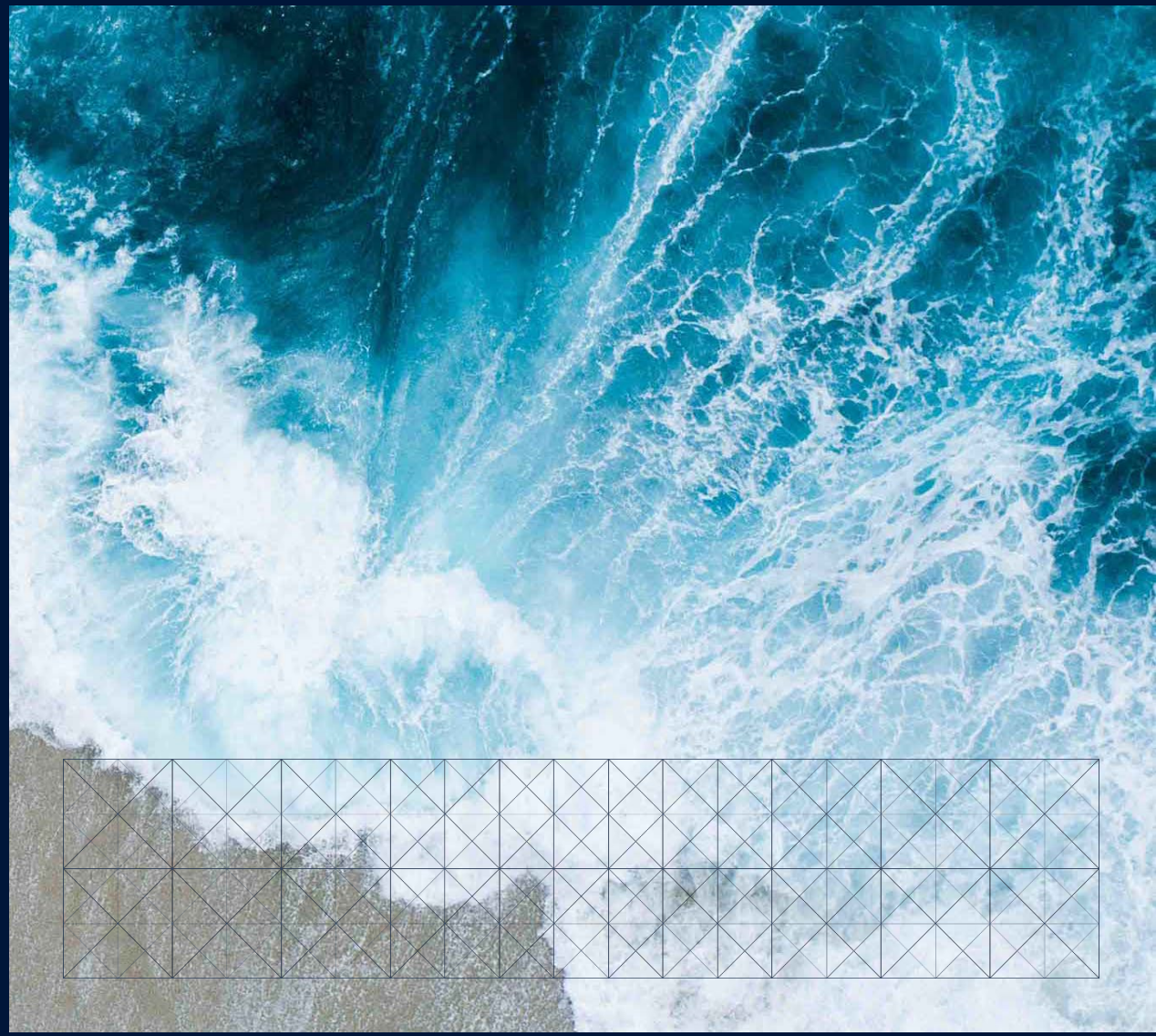
Kongsberg Communication

Arnt-Helge Olsen



Maritime Broadband Radio, MBR

KONGSBERG

- 50 KM range, 31 Miles
- RF 4,9-5,9 GHz
- 0.7 to 16.5 Mbps

With real-time beamforming, the MBR 189 can adjust the antenna direction for every datagram transmitted within a sector of 100° x 100°. In addition to absolute position from a built-in GNSS-receiver, the MBR 189 calculates relative position vector for every datagram received. Hence it provides a GNSS-independent relative position vector to the remote unit. The MBR 189 is suitable for maritime land-to-sea communication and for ground stations for manned and unmanned aircraft operations

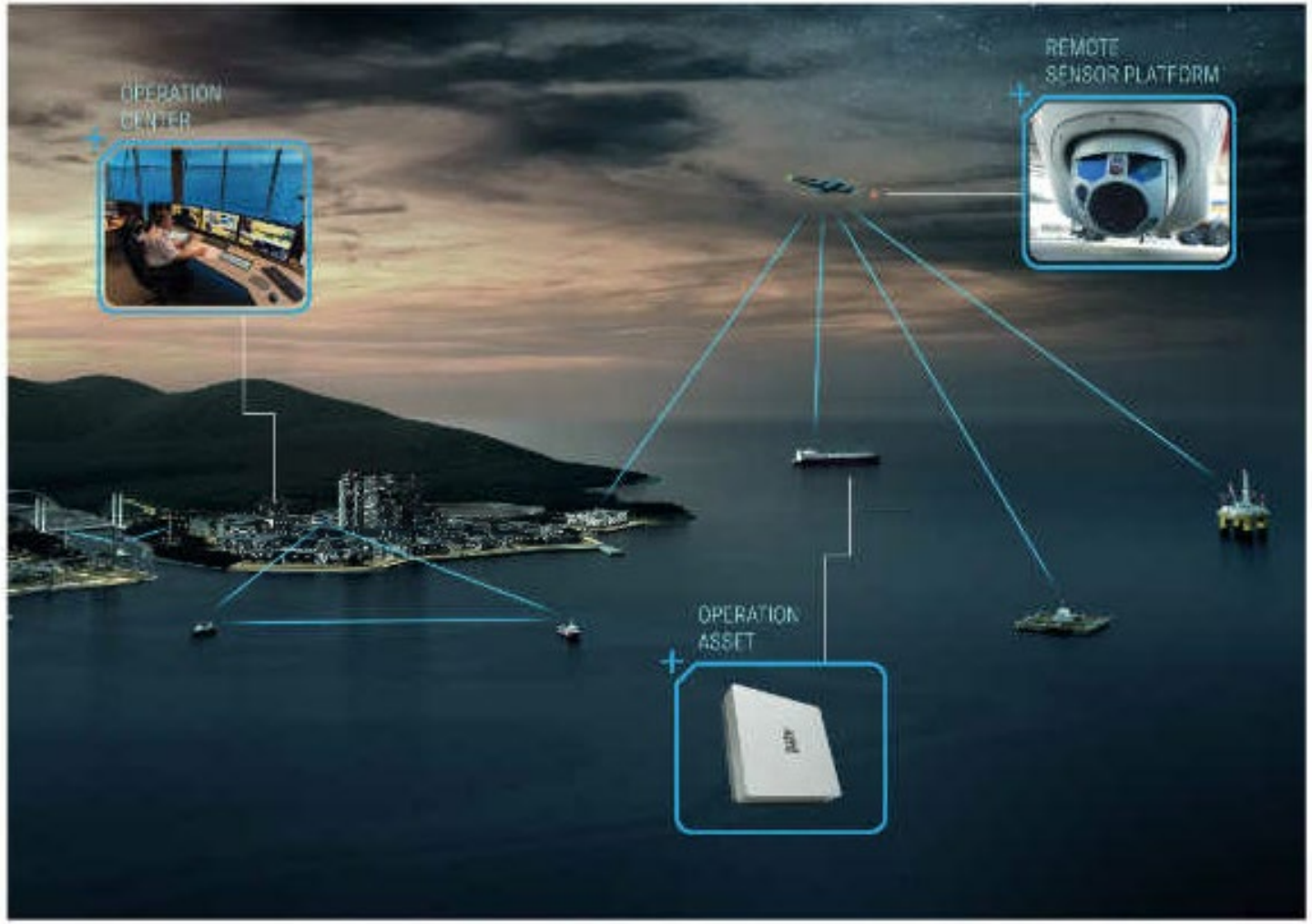
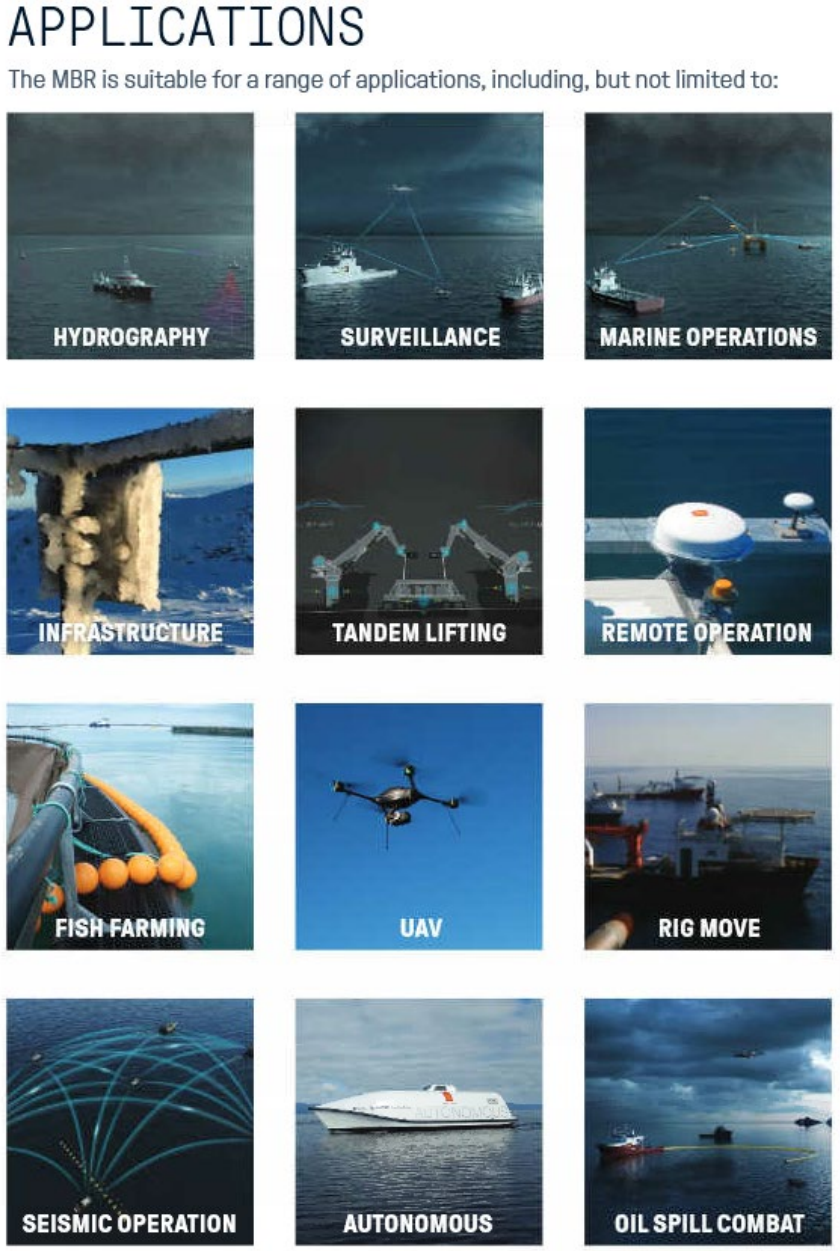


Illustration of a typical MBR setup

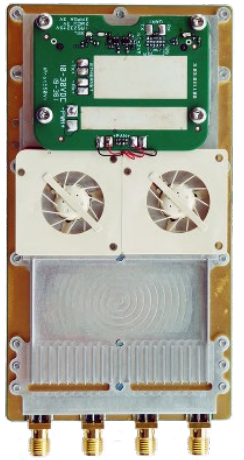
MBR

- THE GAME CHANGER
- With beyond line-of-sight operational range, the MBR is a true game changer in interconnectivity between vessels.
- IP connectivity secures seamless exchange and sharing of data between assets with low latency.
- Possibilities to stream live HD video and voice without any further conventional infrastructure.



MBR

- Sector Smart Antenna
- Compact omni Smart antenna
- Portable body worn smart antenna
- UAV unit
- Oem unit
- Submersible smart antenna



MBR web site.

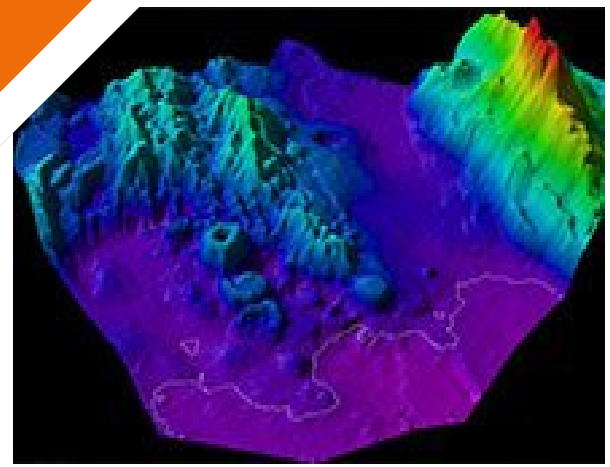
- Www. Connectingvessels.com
- Product description
- Video

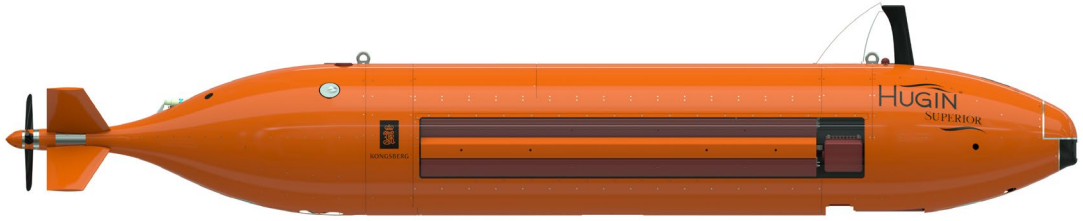
Kongsberg Maritime
Marine Robotics

Sensor and Robotics

KONGSBERG

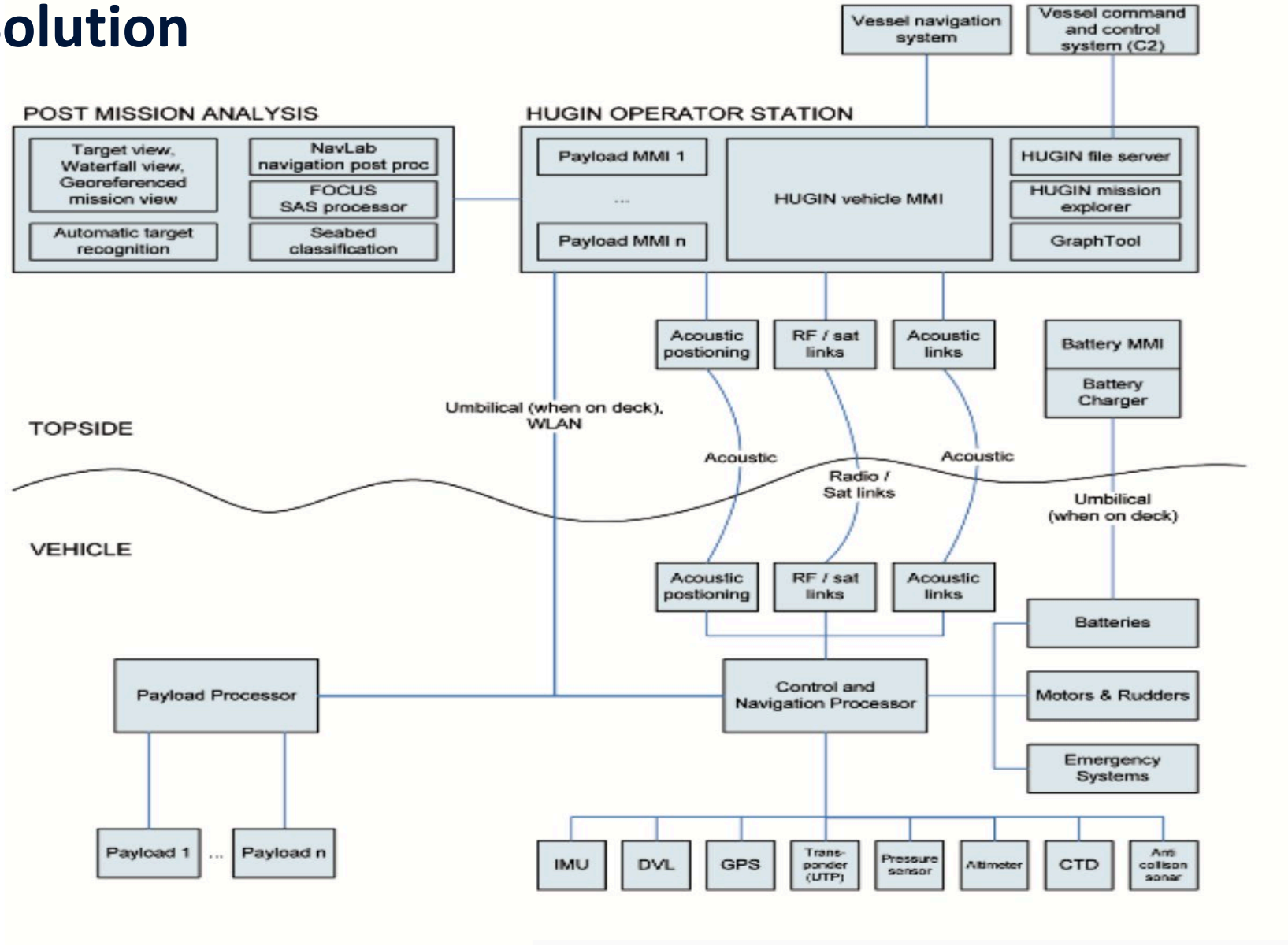
KM deliver systems for dynamic positioning and navigation, marine automation, handling systems, safety management, cargo handling, subsea survey and construction, maritime training, satellite positioning, and autonomous solutions





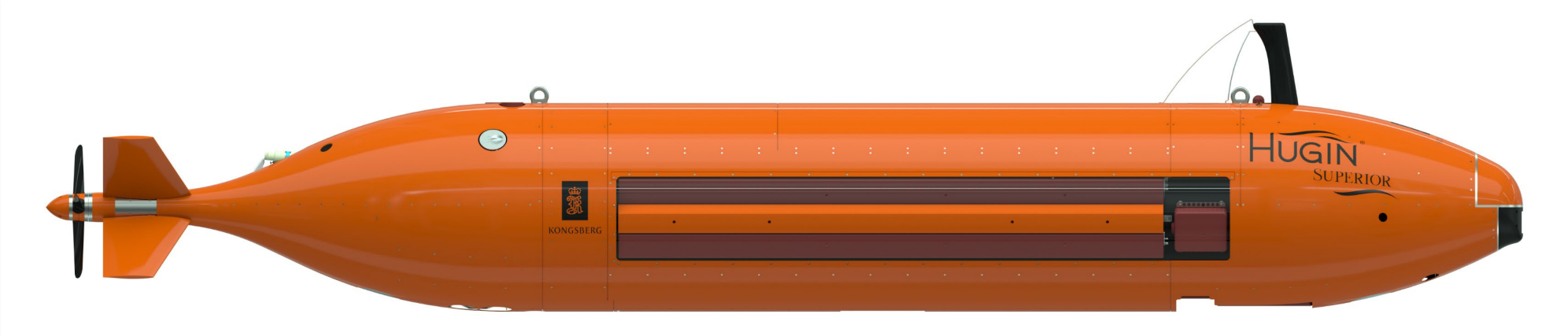
Complete Solution

KONGSBERG



Superior Performance

Collecting more data than any other AUV



- Double the area coverage with HISAS 1032 Dual Receiver
- Micro navigation
- EM2040 Mk2 improved multibeam echosounder swath
- Wide aperture camera and laser

- Improved navigation means longer times between updates
- Increased energy density provides greater productivity
- Faster data download for shorter turn-around between dives

Eelume

Eelume:

- Inspection and intervention in confined spaces
- Valve and torque tool operation
- Long range in transit mode
- Less affected by ocean currents due to slender body
- Modular, scalable and easy to configure
- Subsea resident – no need for surface coms to operate.
- Pre-programmed Autonomous missions
- Task operated mission.

Key features

- Small flexible and agile
- Very Modular
- Resident underwater
- Thether or autonomous

Sounder

K-Mate

Dimensions:

- Length: 8 m
- Width: 2.4 m
- Height: 2 m

Performance:

- Endurance:
  - Standard: >3 days
- Speed: >8 Knots

Equipment:

- Navigation, Communication & Collision Avoidance:
  - Seapath 136
  - AIS 300
  - Radar & Camera
  - MBR
  - INMARSAT & Iridium

Reflection

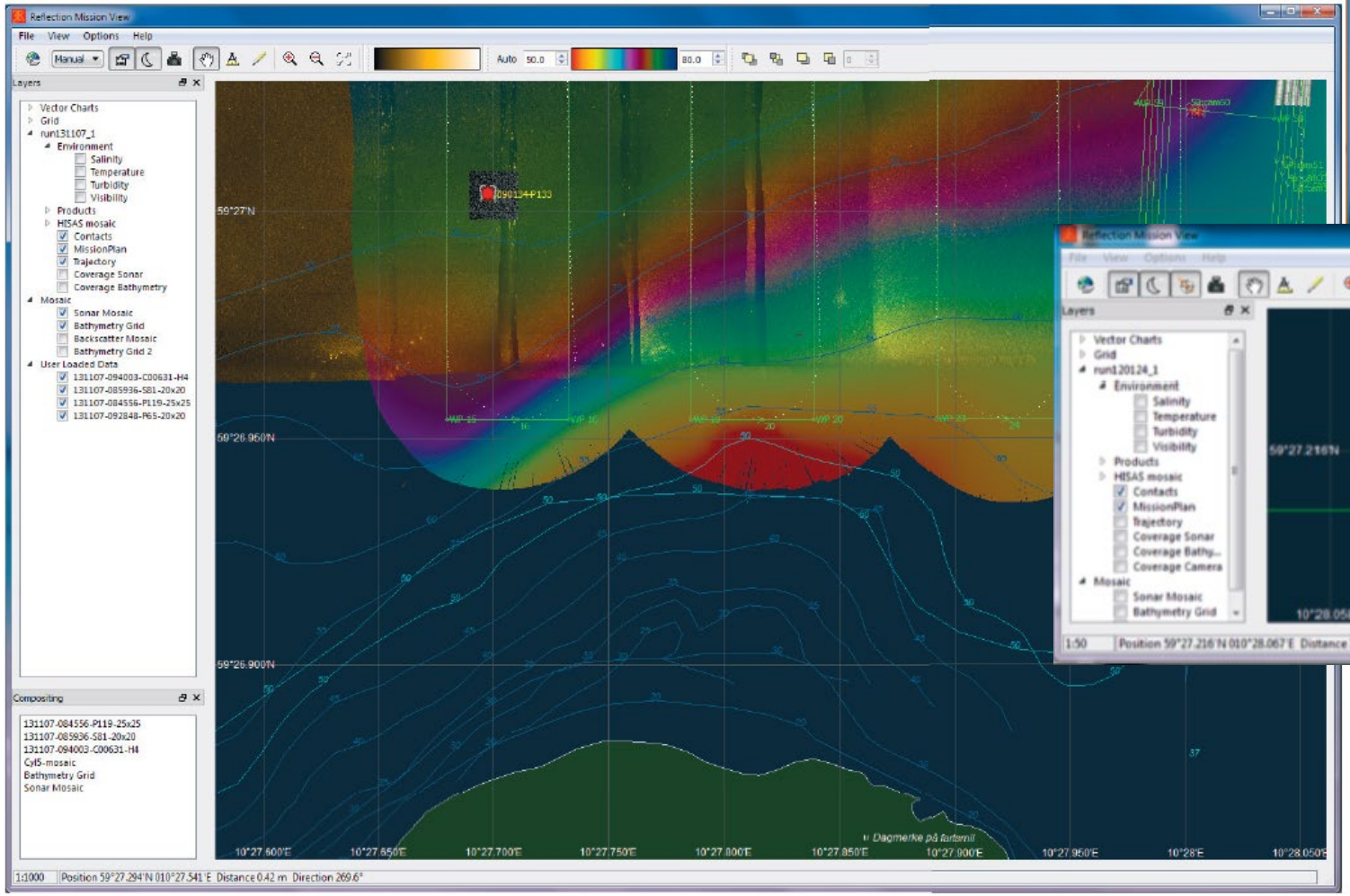
Post mission Analysis

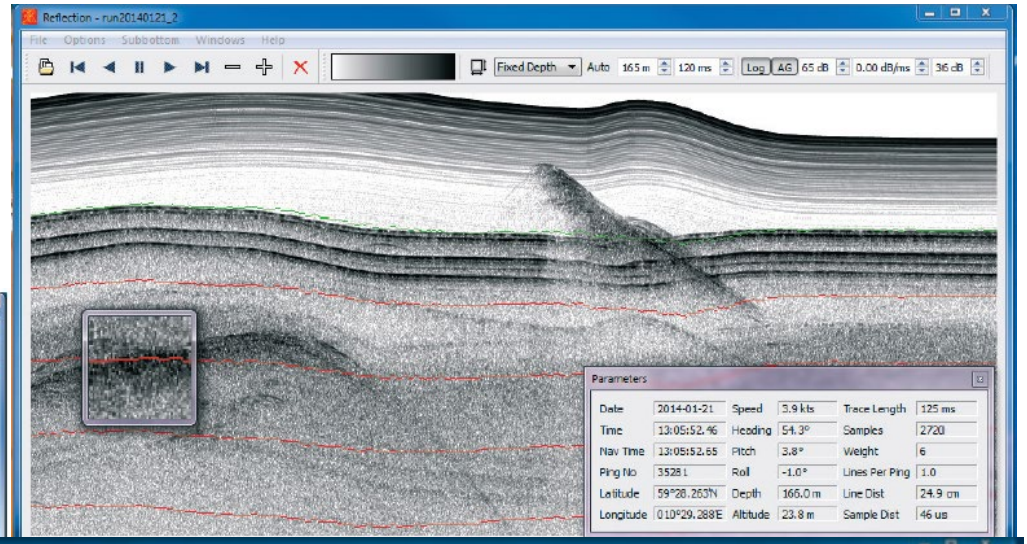
HISAS
EM2040
Camera and Laser
Magnetometer and more

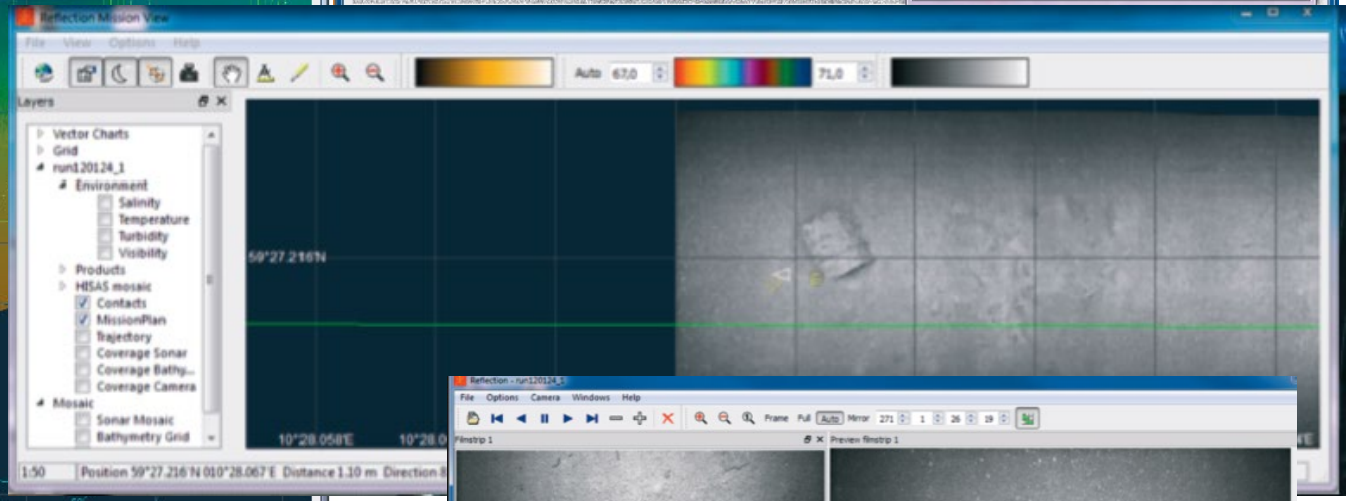
Courtesy of RNoN and FFI

Reflection

KONGSBERG





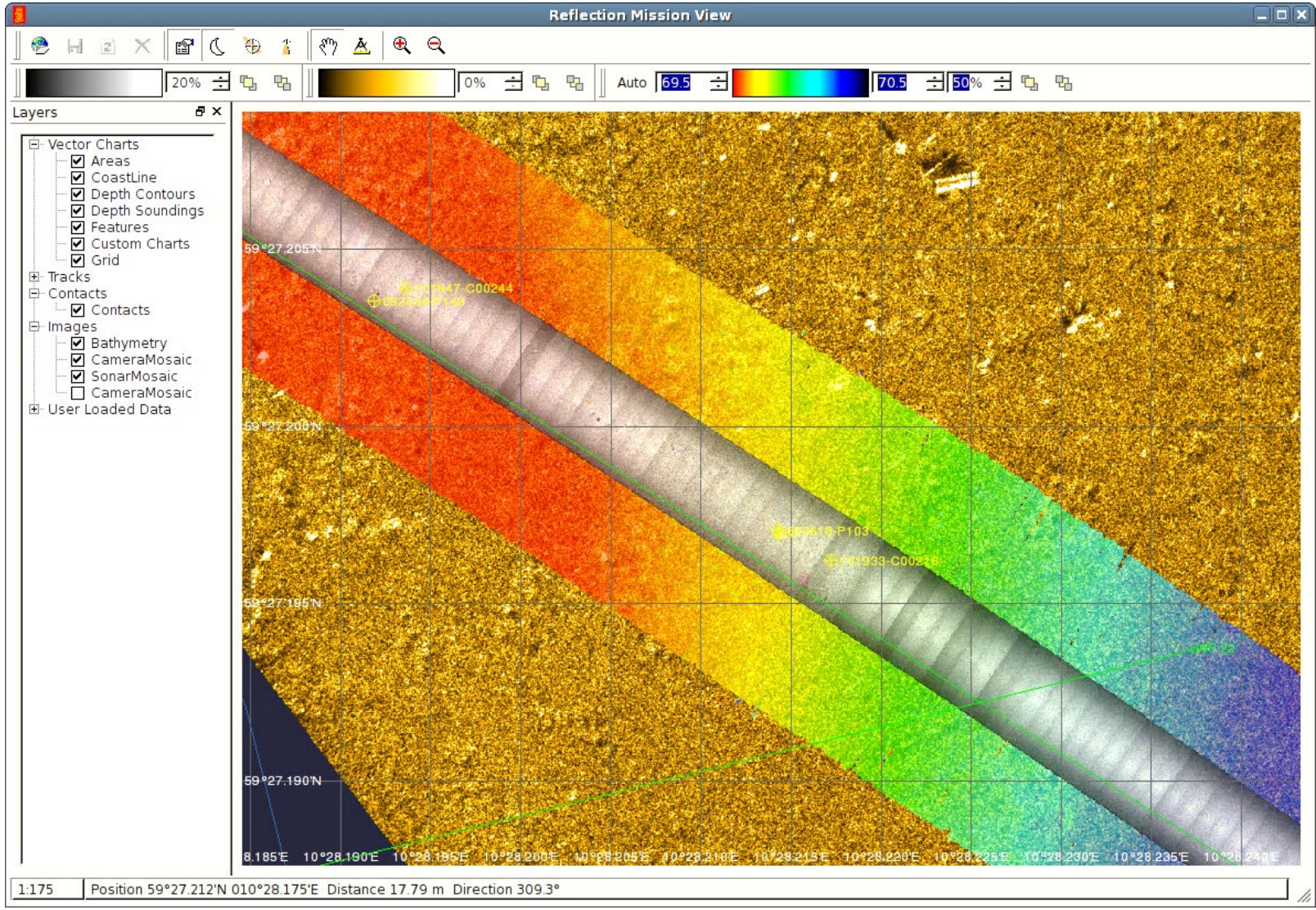


Reflection: Seeing the Data Quickly

KONGSBERG

Reflection PMA:

- Post-mission analysis tool
- Designed for rapid visualization
- Imports data and navigation corrections
- Overlays data from:
  - HISAS
  - EM2040
  - SBP
  - Camera
  - Laser
  - Environmental sensors
- Compatible with HUGIN and MUNIN systems
- Exports in common formats and also to HOS for mission planning



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Thank you!

Jacob.sobin@km.kongsberg.com