KONGSBERG

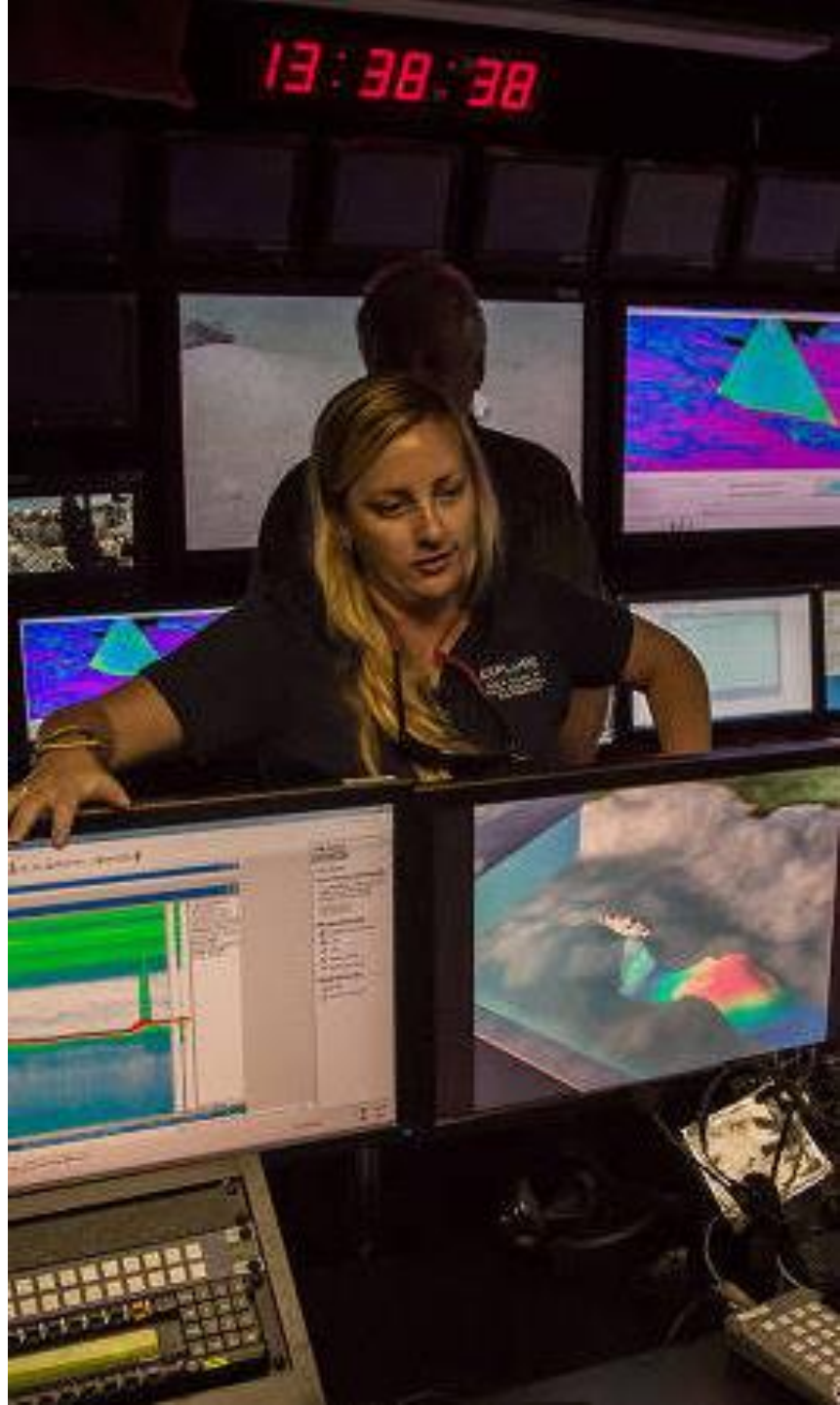
Kongsberg Discovery Tools for Ocean Exploration

Meme Lobecker
Kongsberg Discovery
IRSO – Vancouver , BC
24 September 2024

Image curtesy of Exail
EM2040 on DriX USV

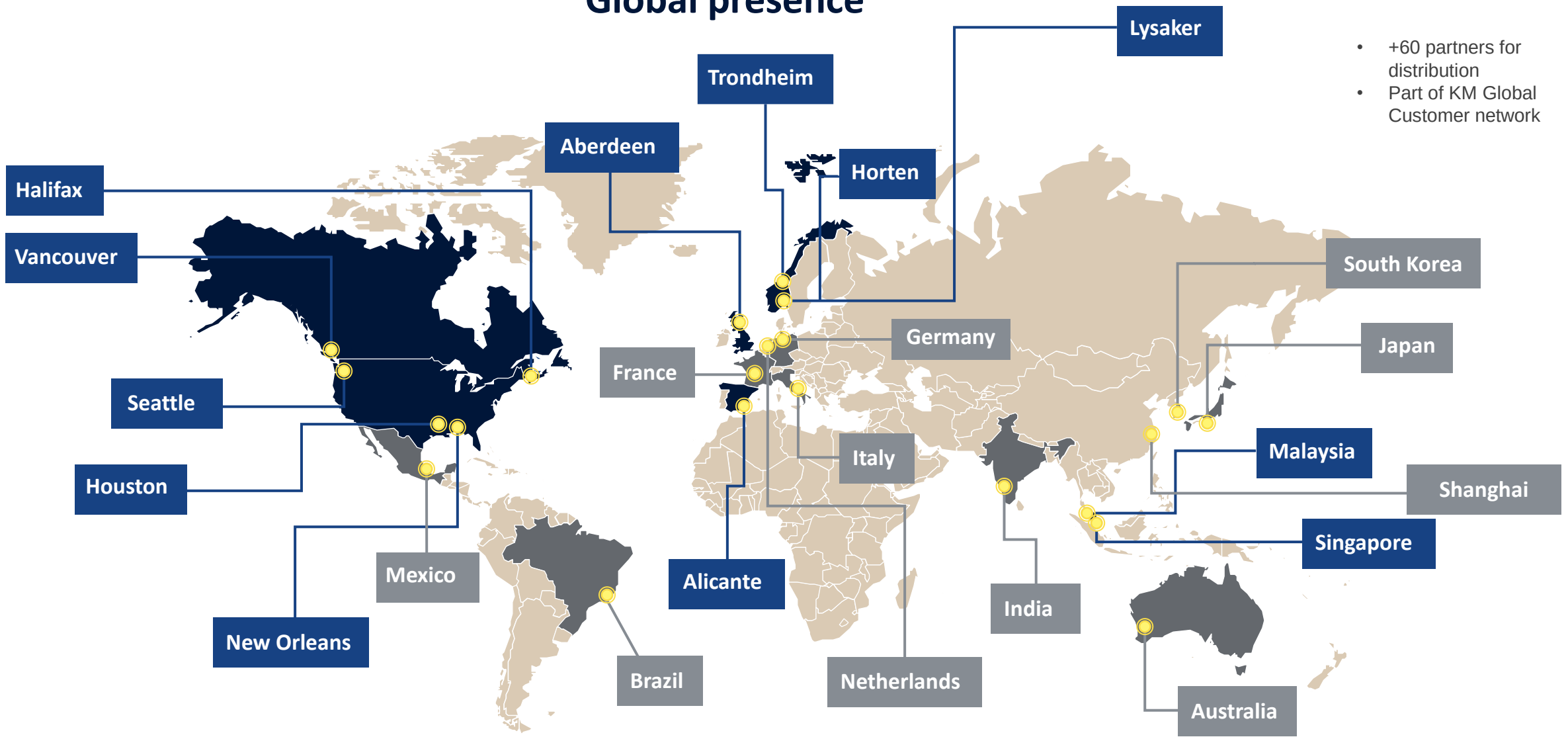
Meme Lobecker

- ~1300 DAS
- Led or co-led operations on 30 NOAA Ship *Okeanos Explorer* cruises (2009-2022)
- Additional extensive experience in shallow water hydrography, industry cable prelay/inspection, minerals exploration, AUV mapping
- 2009 – present based at UNH CCOM-JHC, previously as NOAA, now as Kongsberg Industrial Partner of CCOM supporting US government and academic research fleets, ASVs



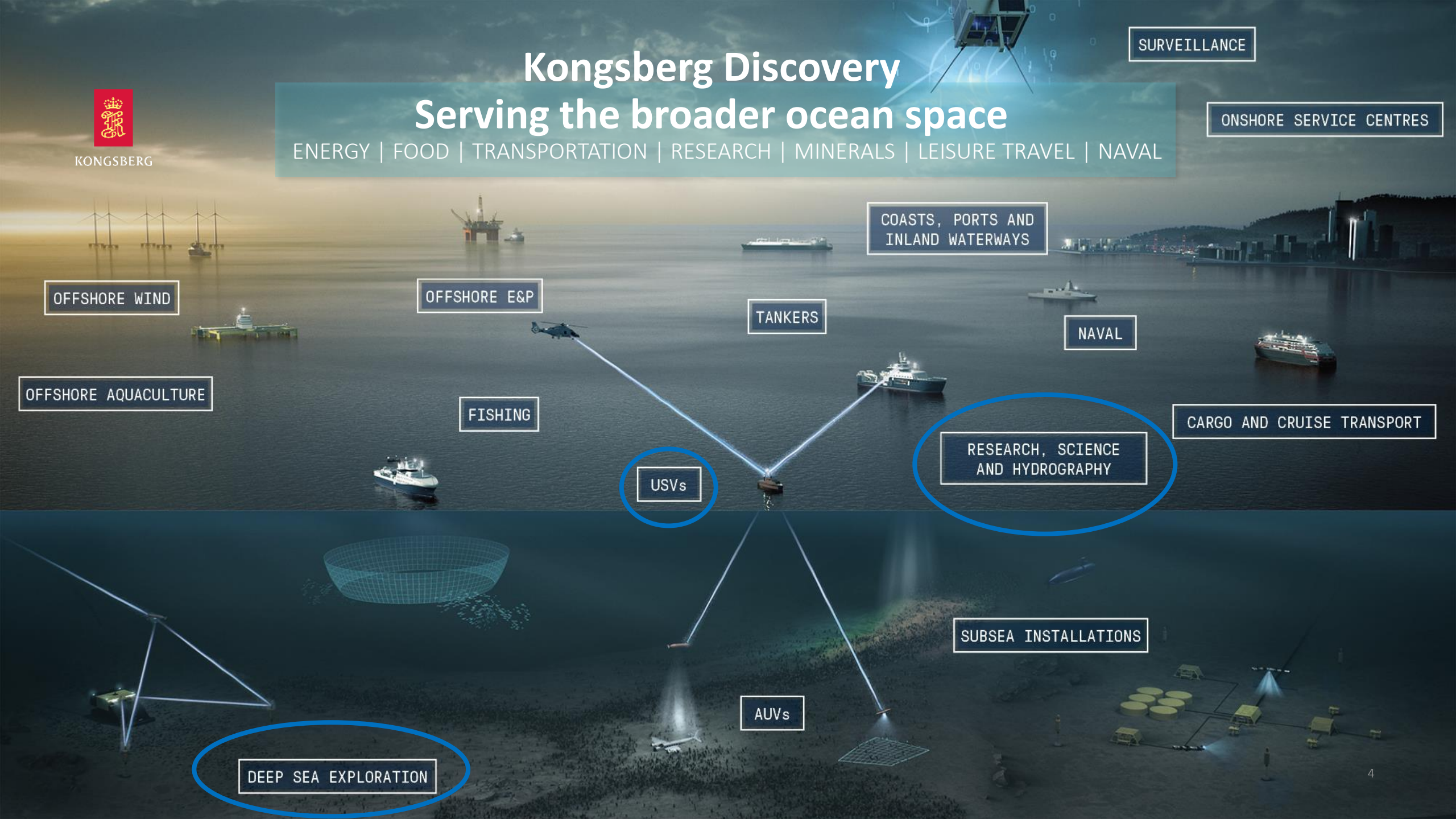
Kongsberg Discovery

Global presence



Kongsberg Discovery
Serving the broader ocean space

ENERGY | FOOD | TRANSPORTATION | RESEARCH | MINERALS | LEISURE TRAVEL | NAVAL



EM 124

- The EM124 operates between **10.5 – 13.5 kHz** with a **nominal frequency of 12 kHz**.
- Depth range from transducers: 10m to **full ocean depth**
- Maximum ping rate: More than 5 Hz

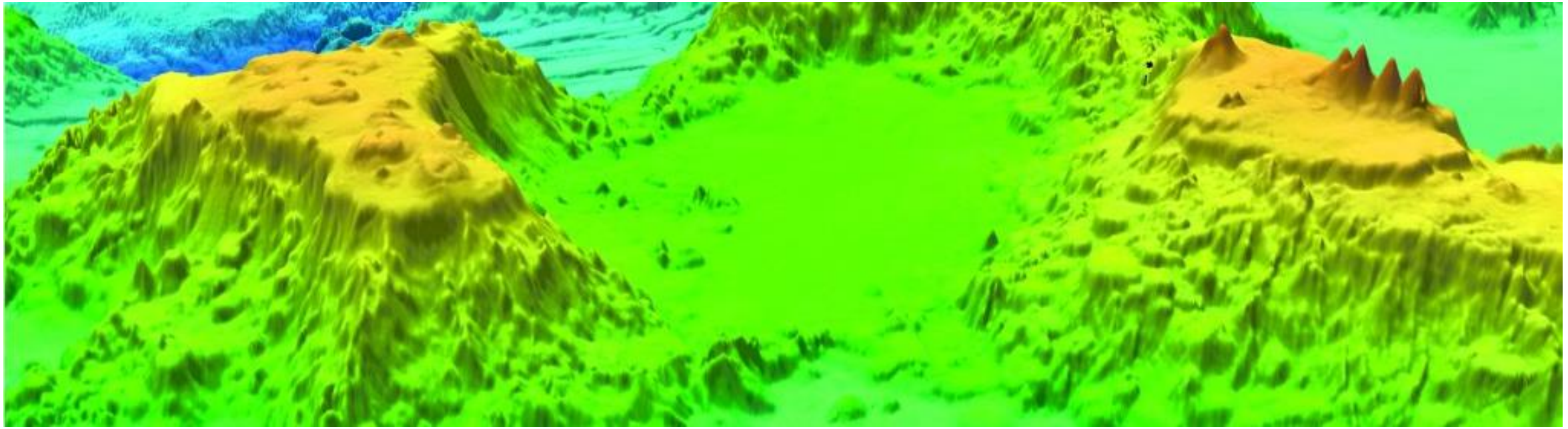
- The EM 124 systems can be configured with different transducer opening angles (TX x RX). Depending on the number of modules.
  - Up to **96 TX** (0.5°) and **16 RX** (1°) modules can be supported.
  - Standard options include 0.5°, 1° or 2° TX and 1°, 2° or 4° RX.

Along ship data resolution:

- Dependent on vessel speed
- Ping rate

Across ship data resolution (Echo sounder opening angle):

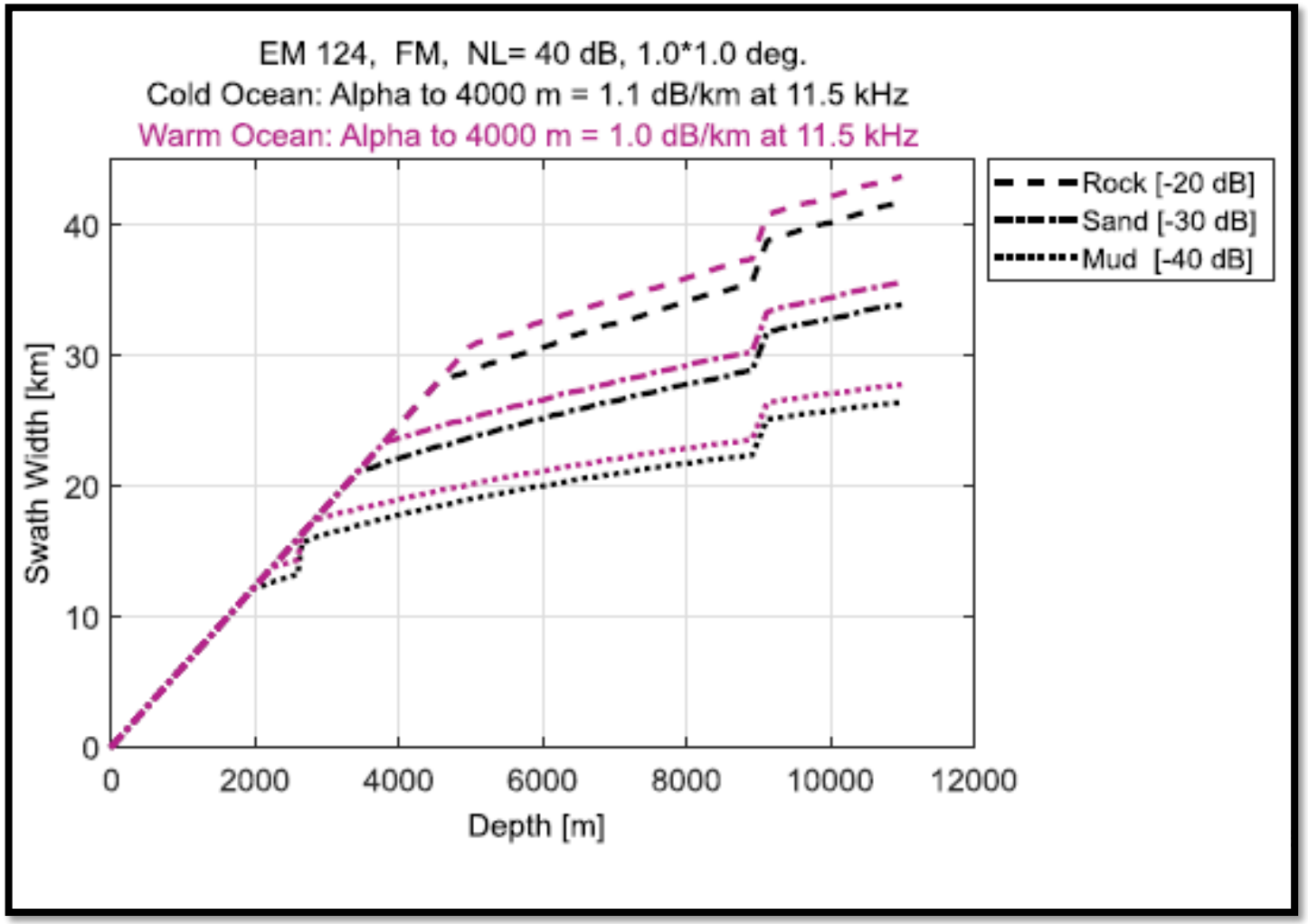
- 4° RX:
  - 512 Beams
  - 1024 beams (dual swath)
- 2° RX:
  - 1024 beams
  - 2048 beams (dual swath)
- 1° RX:
  - 1024 beams
  - 1600 beams (high density)
  - 3200 beams (dual swath)



NOAA Ocean Exploration

EM124

Estimated Coverage



- Angular coverage up to 150°
  - Transmit beam steering
    - **Stabilized for roll, pitch and yaw**
    - 4 sectors in shallow modes
    - 8 sectors in deep modes
  - Receive beam steering **stabilized for roll**
  - Up to **6 times the water depth** swath width
- Beam spacing: Equidistant, Equiangle, High density
- More plots available in the Product Description

Accuracy

EM 124 depth errors:

- On the order of 0.1% of depth
- Limited in very shallow waters by the pulse length

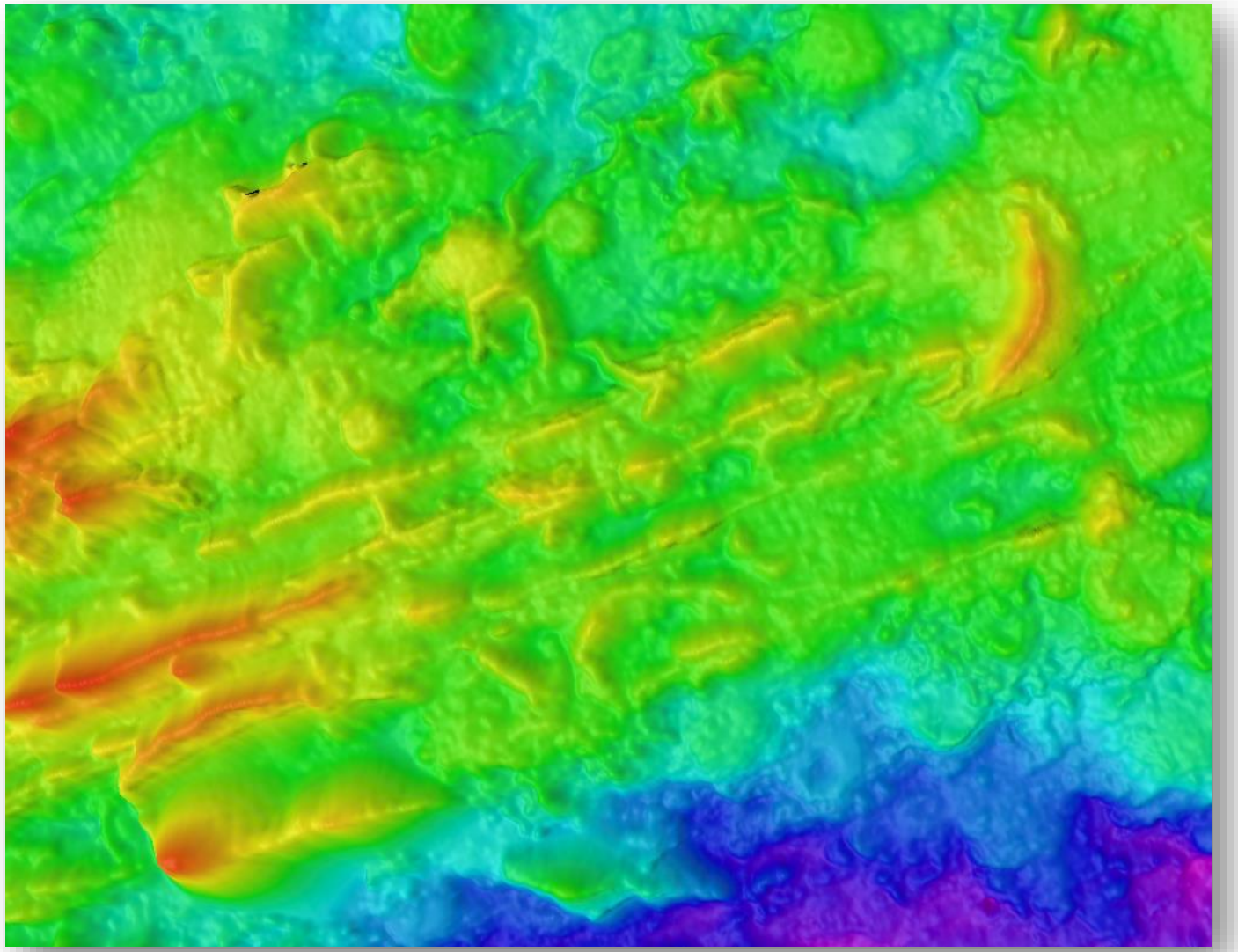
Increases with low signal to noise ratio at large angles across, especially with a short receive array

Expected total system RMS accuracy:

Limited by the pulse length, about 0.5m for the shortest

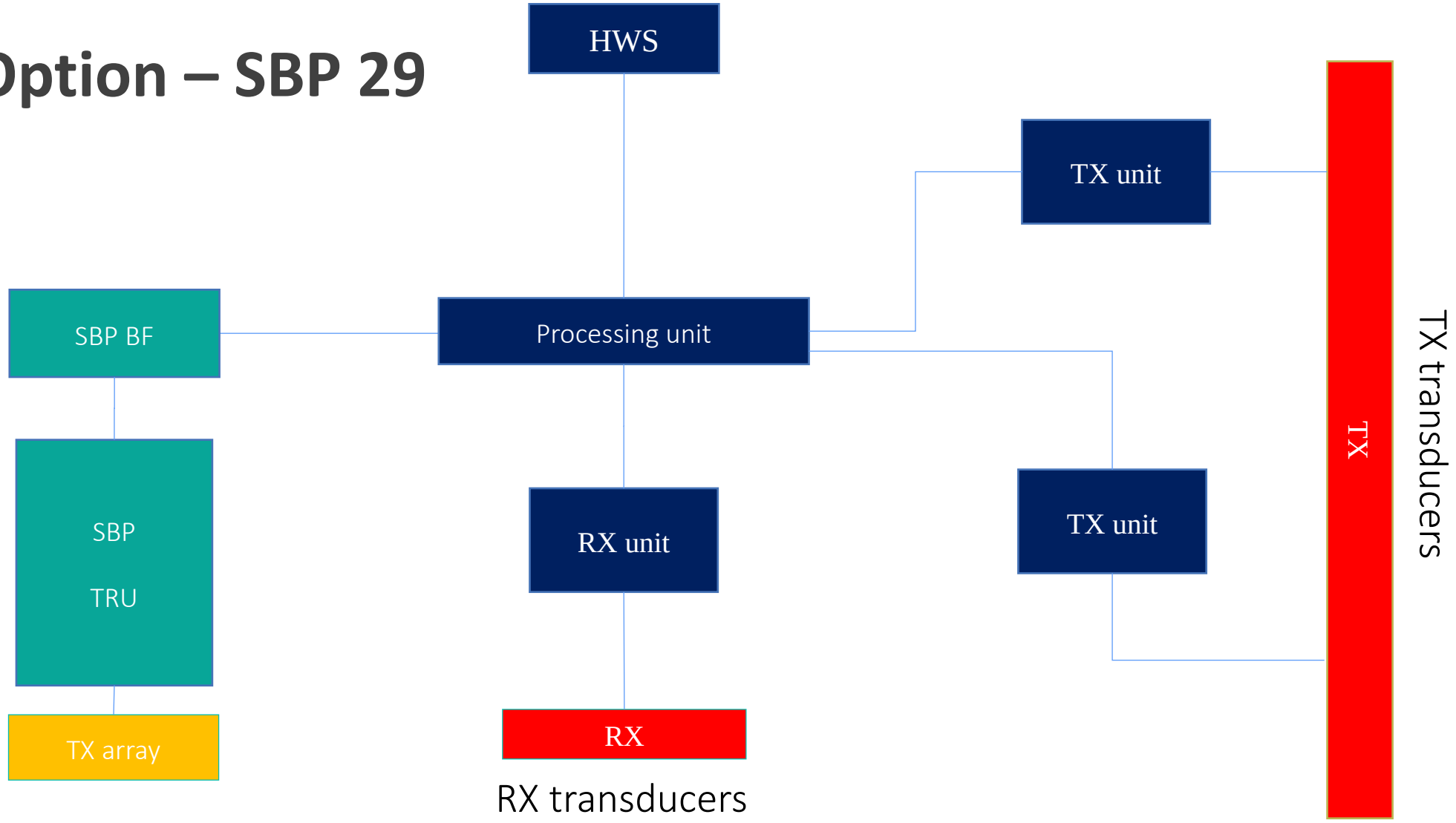
- 0.2% of depth (0° - 45°)
- 0.30% of depth (45° - 60°)
- 0.6% of depth (60° - 70°)

Values based on a correct calibration, high quality external sensors and acceptable oceanographic and weather conditions.



EM124

System Option – SBP 29



This is a 0.5° x 1° system example

EM 304

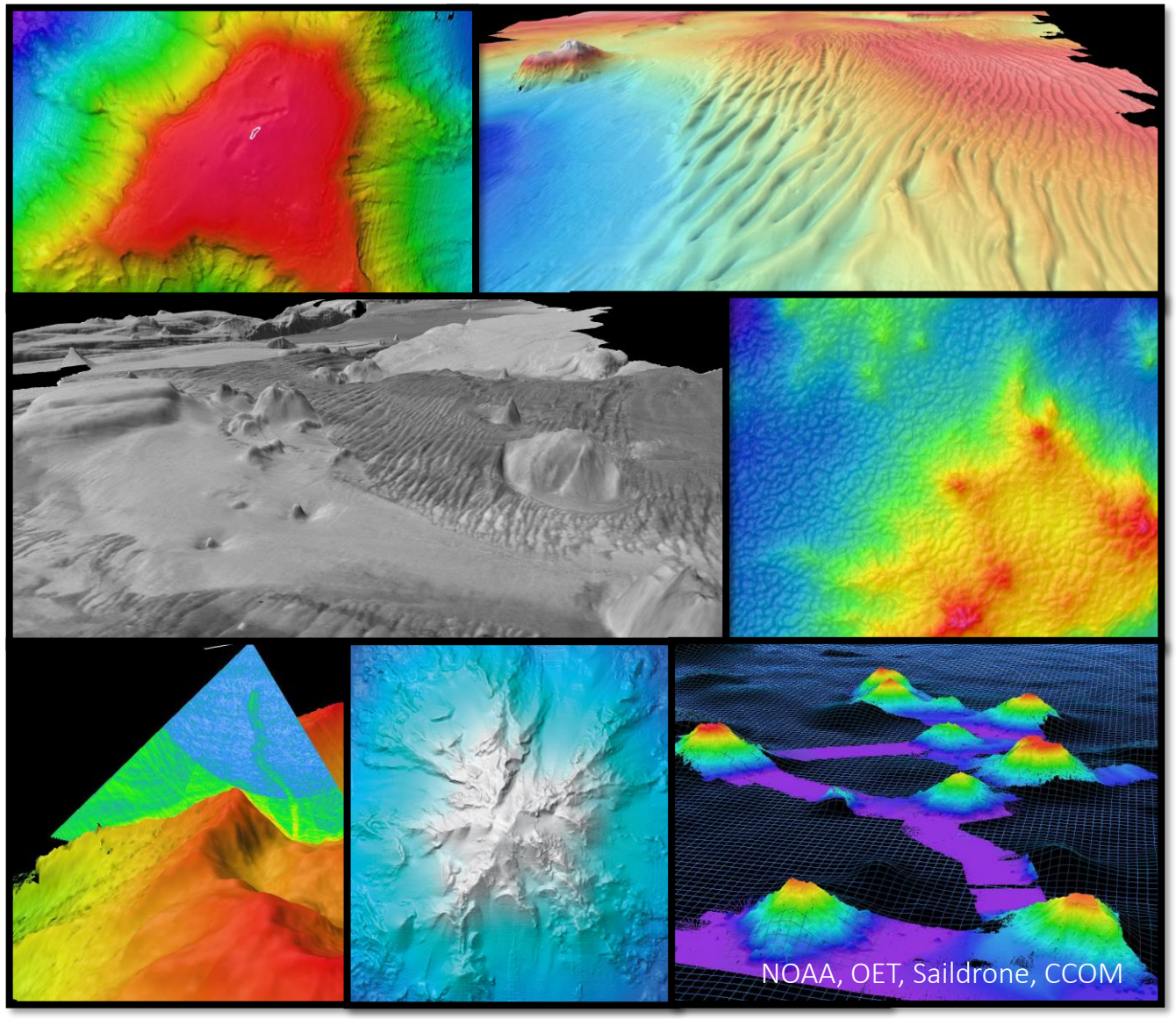
Versions

- The EM 304 operates between **20-32kHz** with a **nominal frequency of 26 kHz**

- EM304 MKI
  - SIS5 software
  - KMAll format
  - Upgrade of TX unit
  - New Hardware and software
  - Upgraded TX transducer and frame

- **EM304 MKII**
  - **Full ocean depth**
  - **Widest swath**

- EM304 MKII USV
  - Direct DC input
  - Fewer units to install
  - Fewer cables
  - *MKI systems can be converted*



EM304 MKII

Resolution

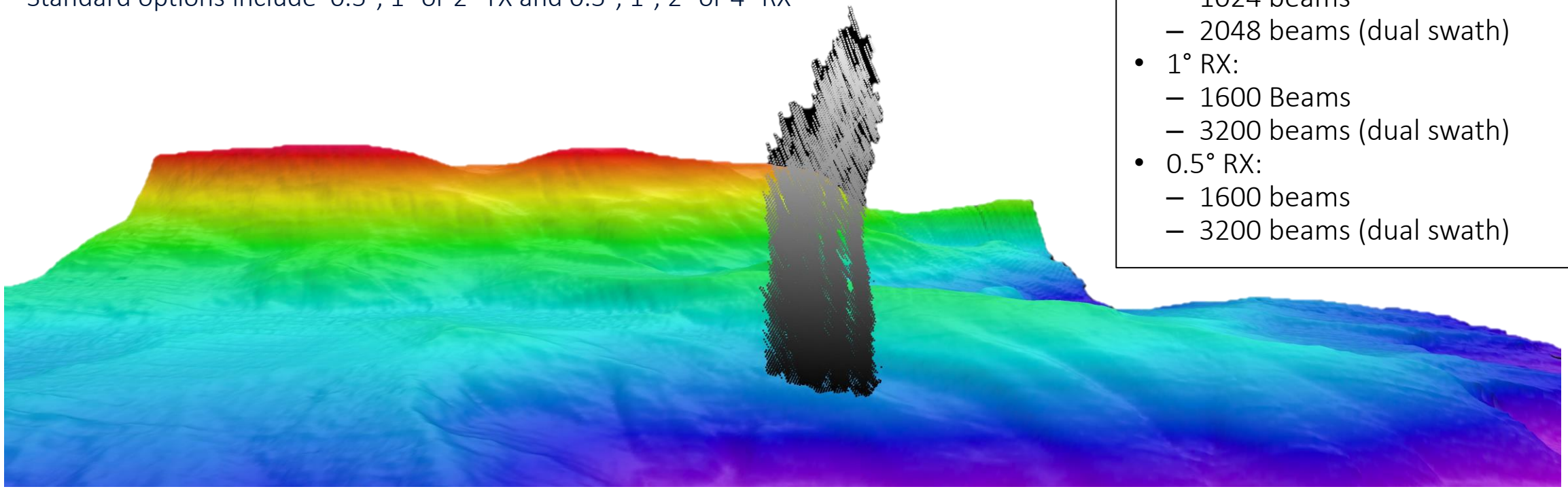
- The EM 304 MKII systems can be configured with different transducer opening angles (TX x RX) depending on the number of modules.
- Up to **24 TX** (0.3°) and **16 RX** (0.5°) modules can be supported.
- Standard options include 0.5°, 1° or 2° TX and 0.5°, 1°, 2° or 4° RX

Along ship data resolution:

- Dependent on vessel speed
- Ping rate

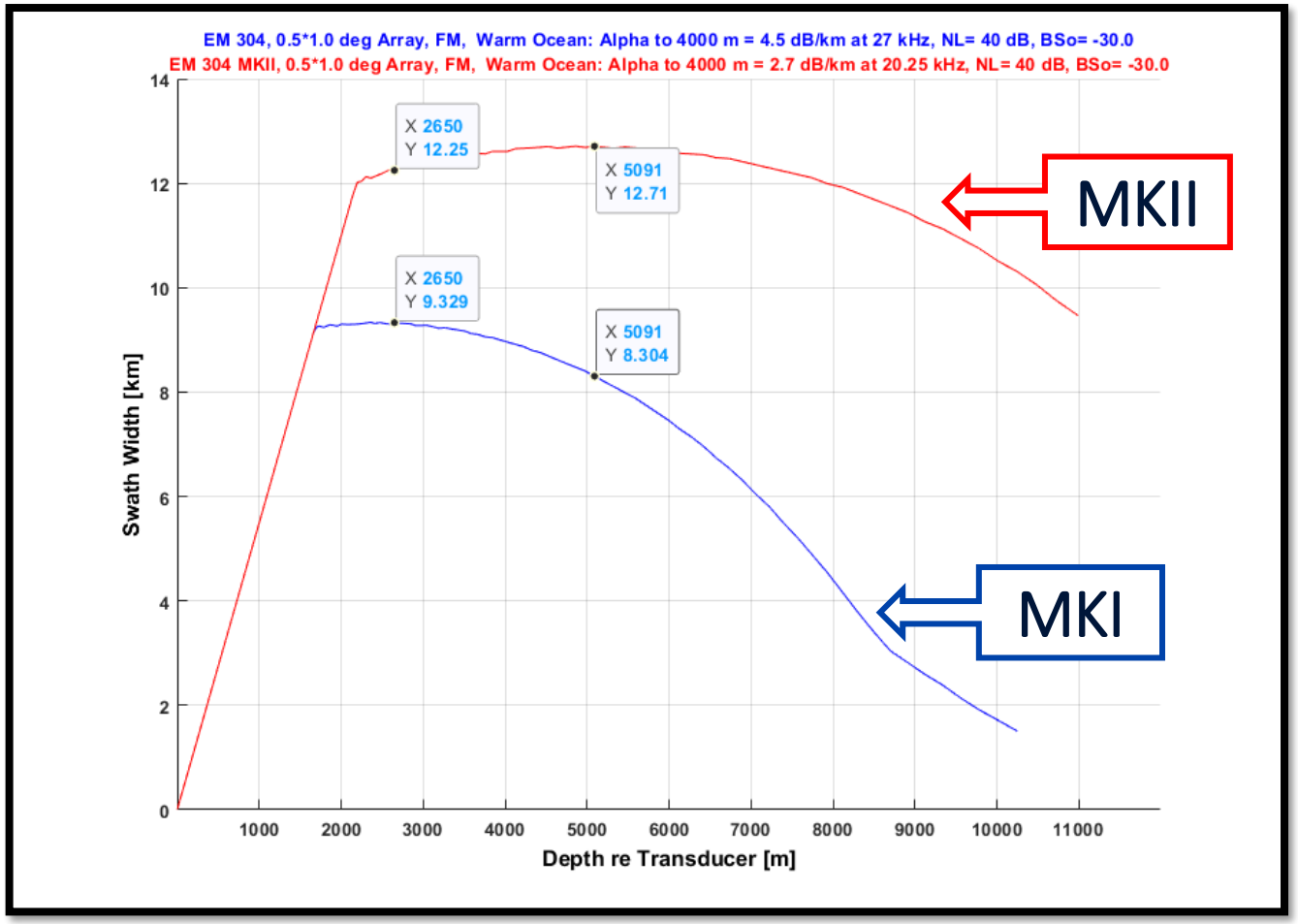
Across ship data resolution (Echo sounder opening angle):

- 4° RX:
  - 512 Beams
  - 1024 beams (dual swath)
- 2° RX:
  - 1024 beams
  - 2048 beams (dual swath)
- 1° RX:
  - 1600 Beams
  - 3200 beams (dual swath)
- 0.5° RX:
  - 1600 beams
  - 3200 beams (dual swath)

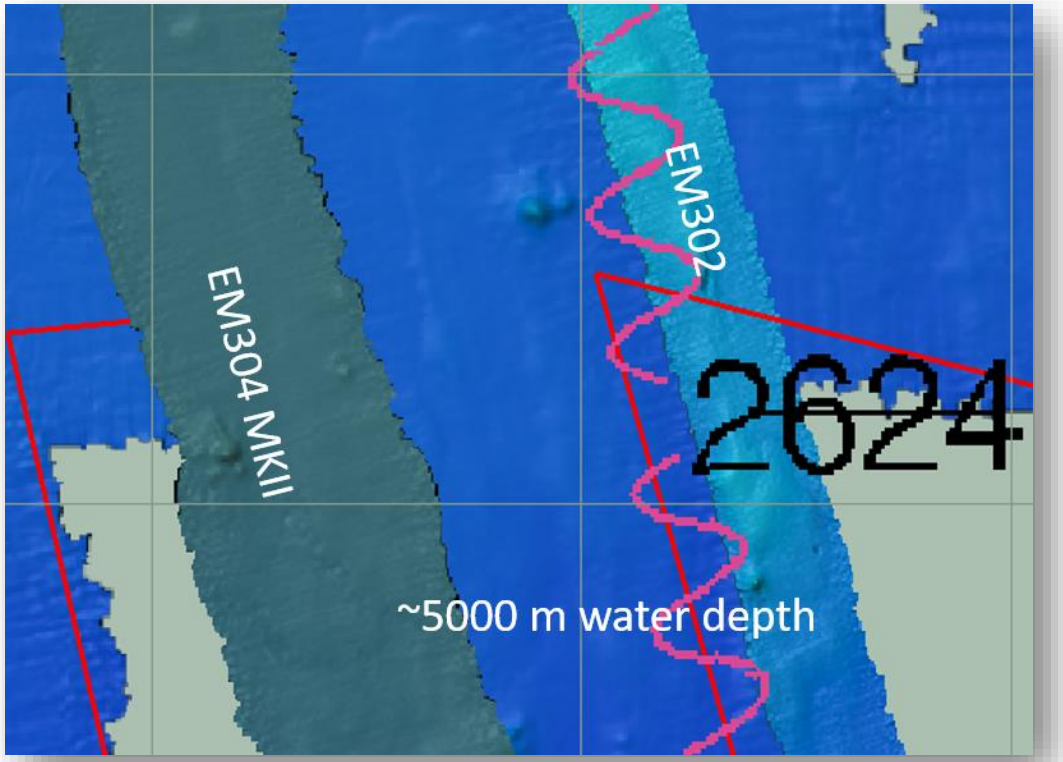


NOAA Ocean Exploration

Estimated Coverage

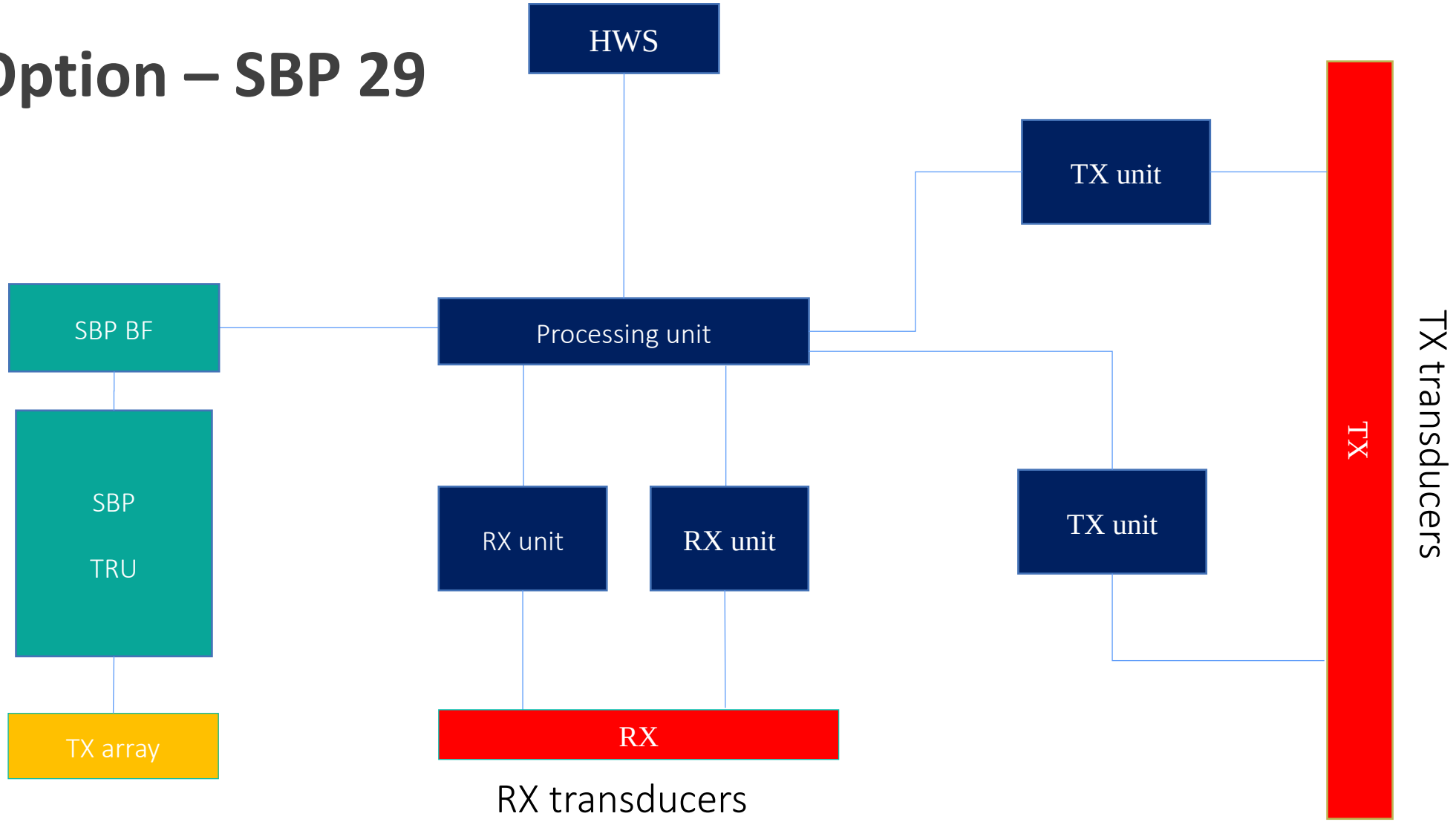


- Improved depth range
- Wider swath : 302 → 304 MKII = 2x swath @5,000m



EM304 MKII

System Option – SBP 29



This is a 0.5° x 0.5° system example

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EM304 MKII

Accuracy

EM304 MKII depth errors:

- On the order of 0.1% of depth
- Limited in very shallow waters by the pulse length

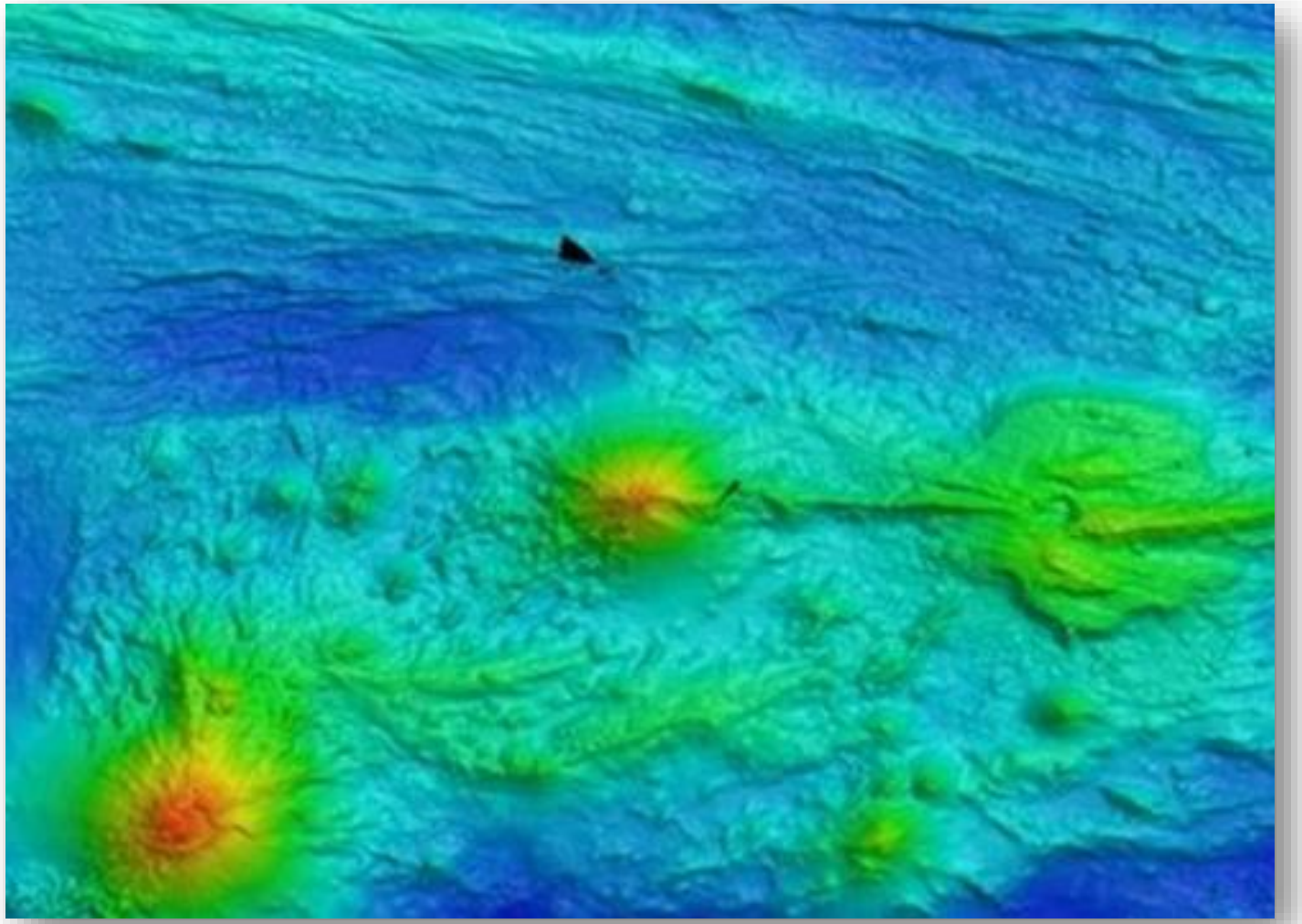
Increases with low signal to noise ratio at large angles across, especially with a short receive array

Expected total system RMS accuracy:

Limited by the pulse length, about 0.25m for the shortest

- 0.2% of depth (0° - 45°)
- 0.3% of depth (45° - 60°)
- 0.6% of depth (60° - 70°)

Values based on a correct calibration, high quality external sensors and acceptable oceanographic and weather conditions.



Versions

- The EM712 operates between **40-100 kHz**

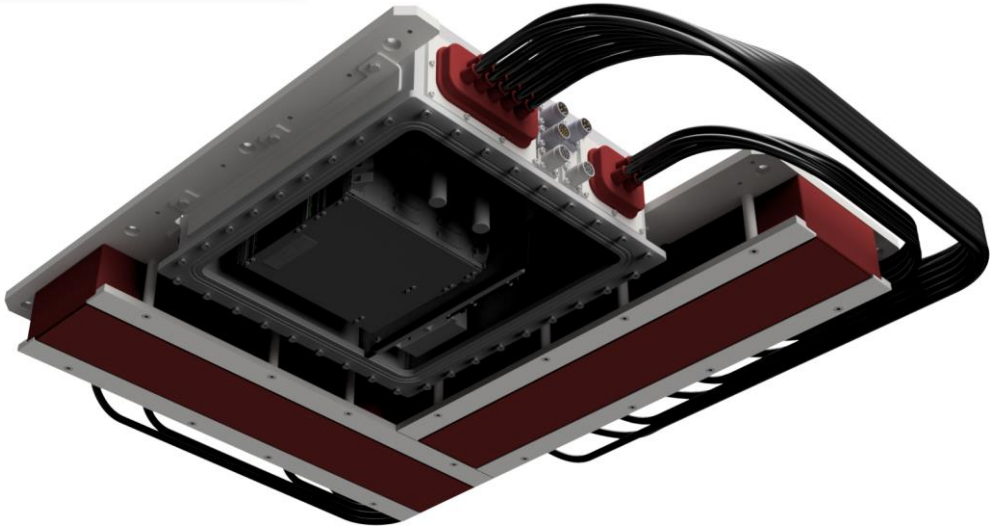
- **EM712 (Full performance)**
  - CW and FM pulse
  - No depth limitations
  - Depth range 3600m

- **EM712 RD (Reduced depth)**
  - Short CW pulse
  - Restricted to 600 m water depth

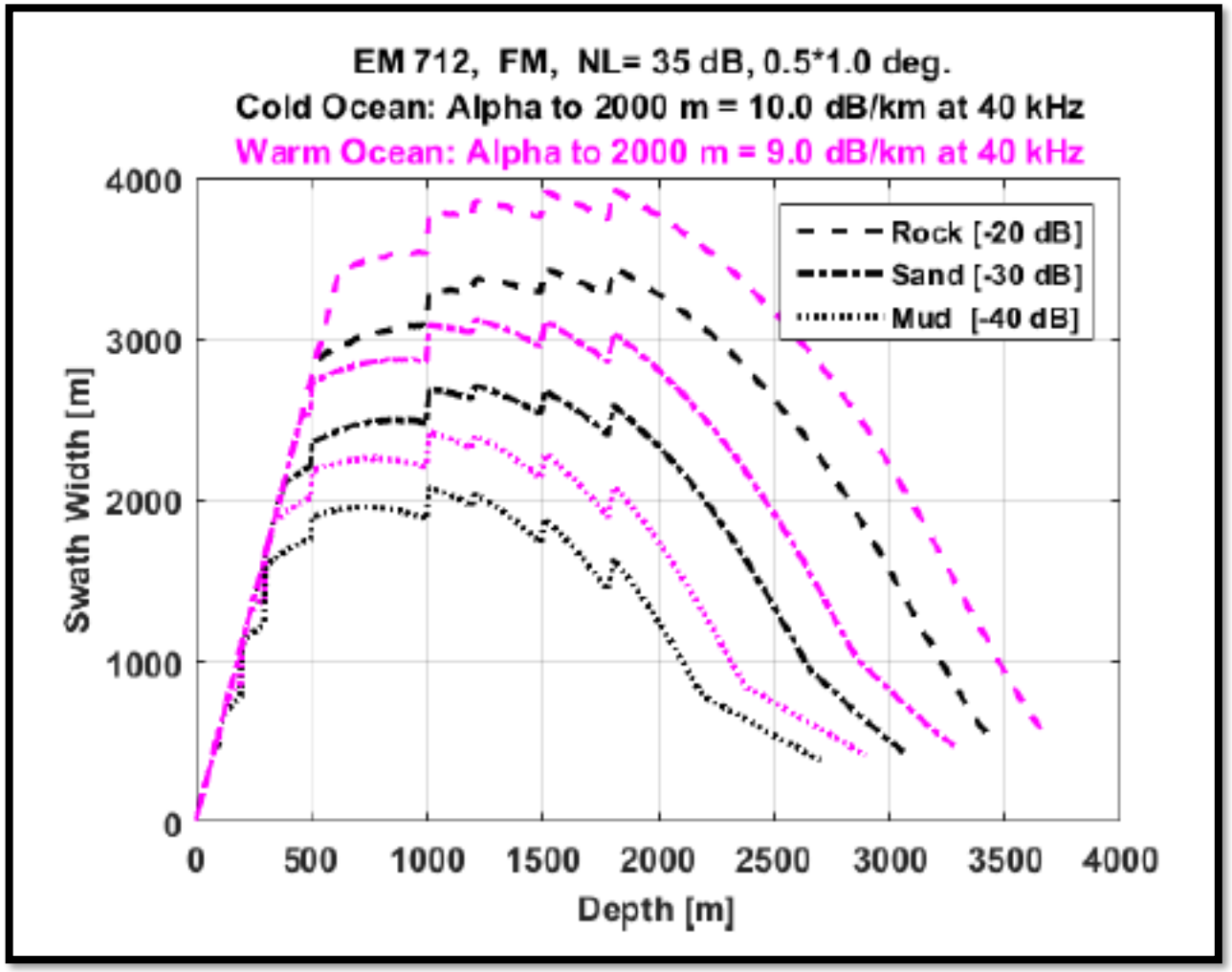
- **EM712 S (Shallow)**
  - CW pulse only
  - Typical depth range 1000 m

- **EM712 USV**
  - EM712 1x1 with electronics in one underwater unit
  - Depth range 3000m

- *Note: Reduced versions may be upgraded*



Estimated Coverage



- Depth range from transducers: 3 to **3600m**
  - In the deepest modes (from Very Deep mode) long FM pulses are prioritized. Dual swath is not available in these modes.
- Results vary based on system and selected frequency
- Maximum ping rate: More than 30 pings per second
- Angular coverage up to 140°
  - Transmit beam steering in 3 sectors
    - **Stabilized for roll, pitch and yaw**
  - Receive beam steering **stabilized for roll**
  - Up to **5.5 x water depth** swath width
- Beam spacing: Equidistant, Equiangle, High density
- More plots available in the Product Description

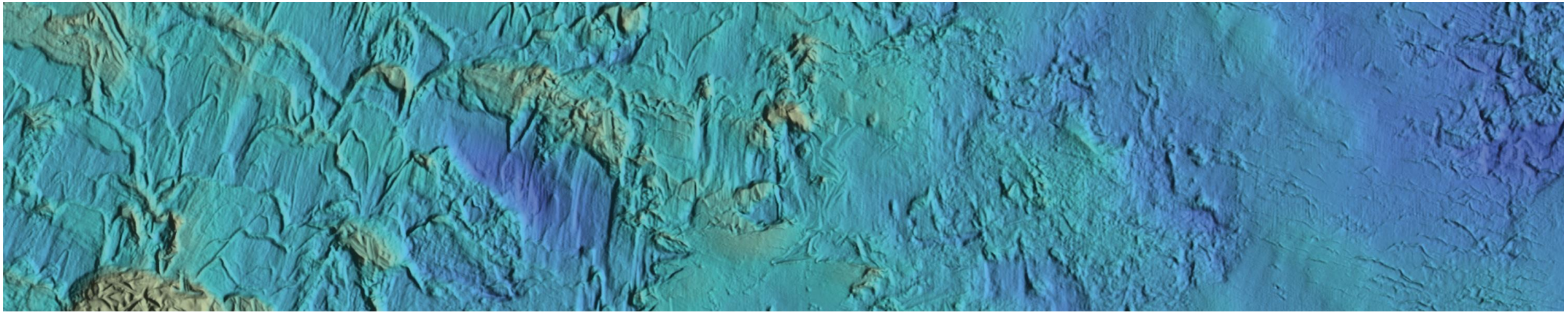
EM712

Resolution

- The EM712 systems can be configured with different transducer opening angles (TX x RX).
  - Any combination of **0.25°, 0.5°, 1° or 2° TX** and **0.5°, 1° or 2° RX** can be configured depending on the system version.
  - EM712 S and EM712 RD can be upgraded with licensing.

Along ship data resolution:
- Dependent on vessel speed
- Ping rate

Across ship data resolution (Echo sounder opening angle):
- 2° RX:
  - 128 Beams
  - 200 beams (high density)
  - 400 beams (dual swath)
- 1° RX:
  - 256 Beams
  - 400 beams (high density)
  - 800 beams (dual swath)
- 0.5° RX:
  - 512 beams
  - 800 beams (high density)
  - 1600 beams (dual swath)



Note: 0.25° and 0.5° TX and 0.5° RX are not available for the RD model. *1° TX and 1° RX are standard for the USV model.*

EM712

Accuracy

EM712 depth errors:

- On the order of 0.1% of depth
- In very shallow waters about 5cm

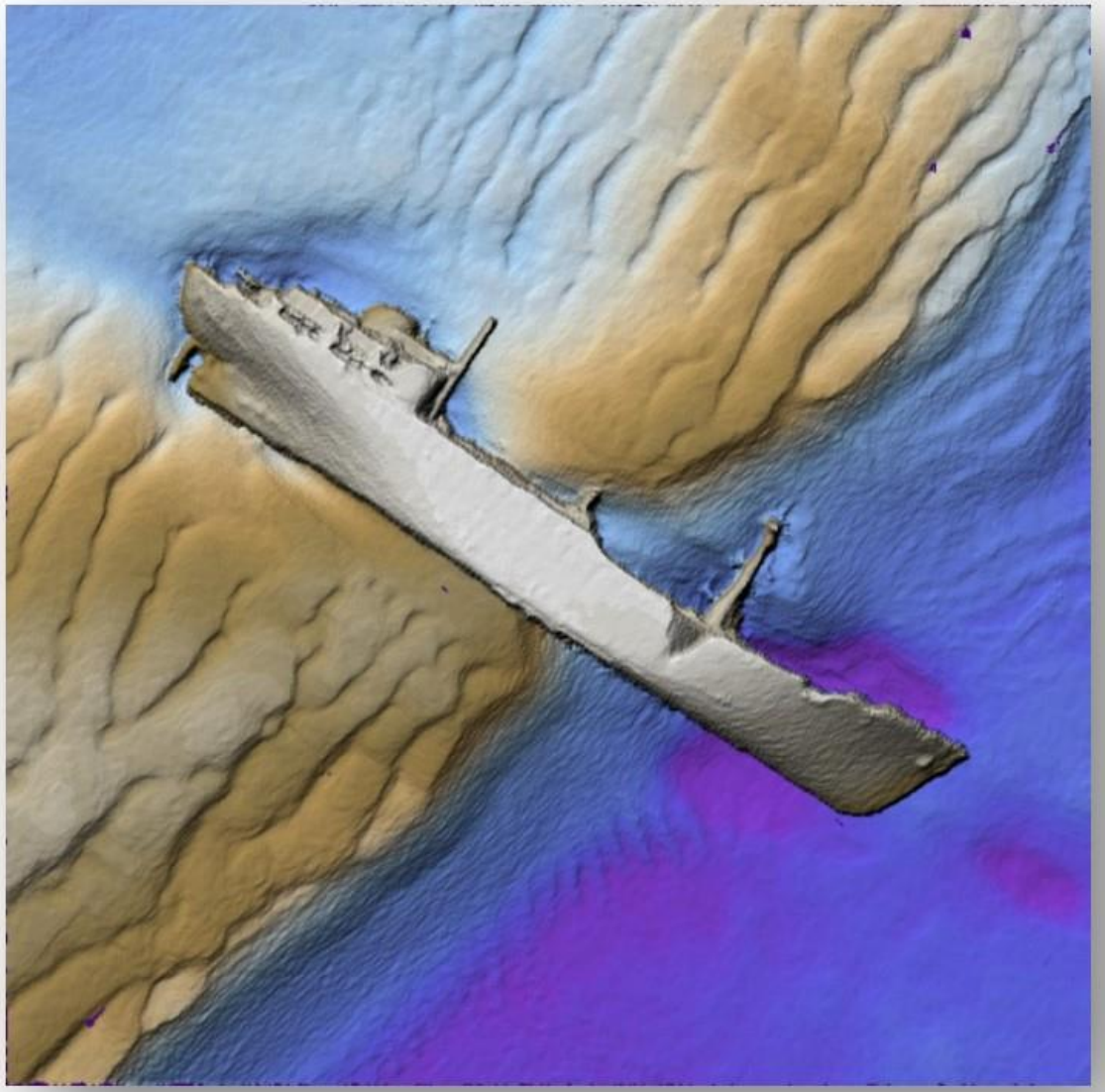
Increases with low signal to noise ratio at large angles across, especially with a short receive array

Expected total system RMS accuracy:

Better than 5 cm

- 0.15% of depth (0° - 45°)
- 0.20% of depth (45° - 60°)
- 0.40% of depth (60° - 70°)

Values based on a correct calibration, high quality external sensors and acceptable oceanographic and weather conditions.



Kongsberg

Pod

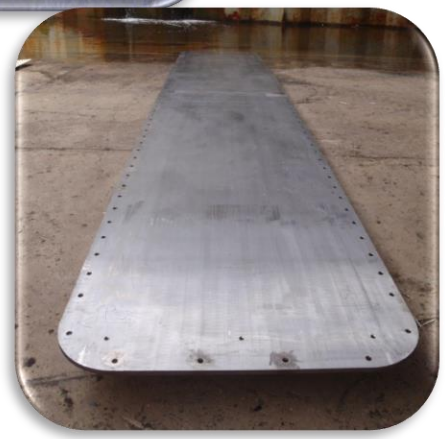
- Mount on a pole or USV
- Vessel of opportunity
- 2° x 2° system

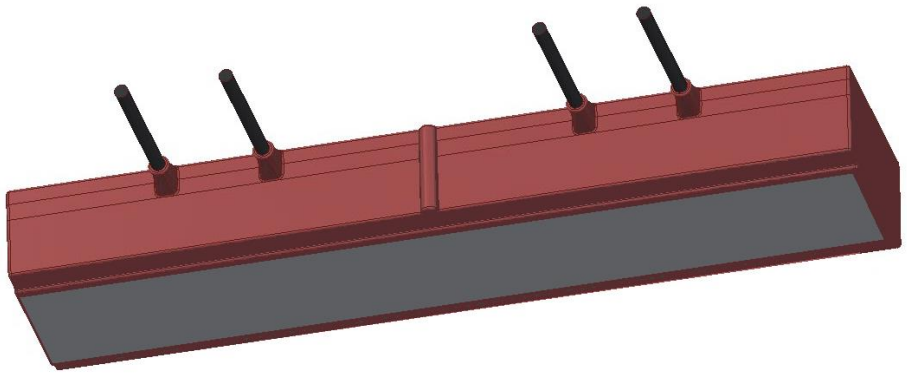
Retractable Keel

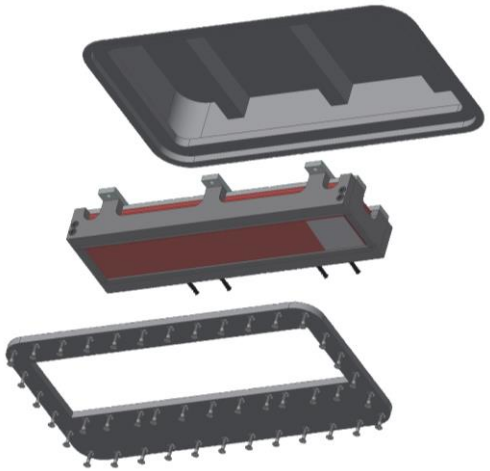
EM712 USV DC

Option – Ice Windows

- Ice windows are offered for EM 124, EM 304, and EM 712
- Options vary by system but can include titanium plates, titanium rods, and Hyperlast plates







Synchronization Unit

Option – K-Sync

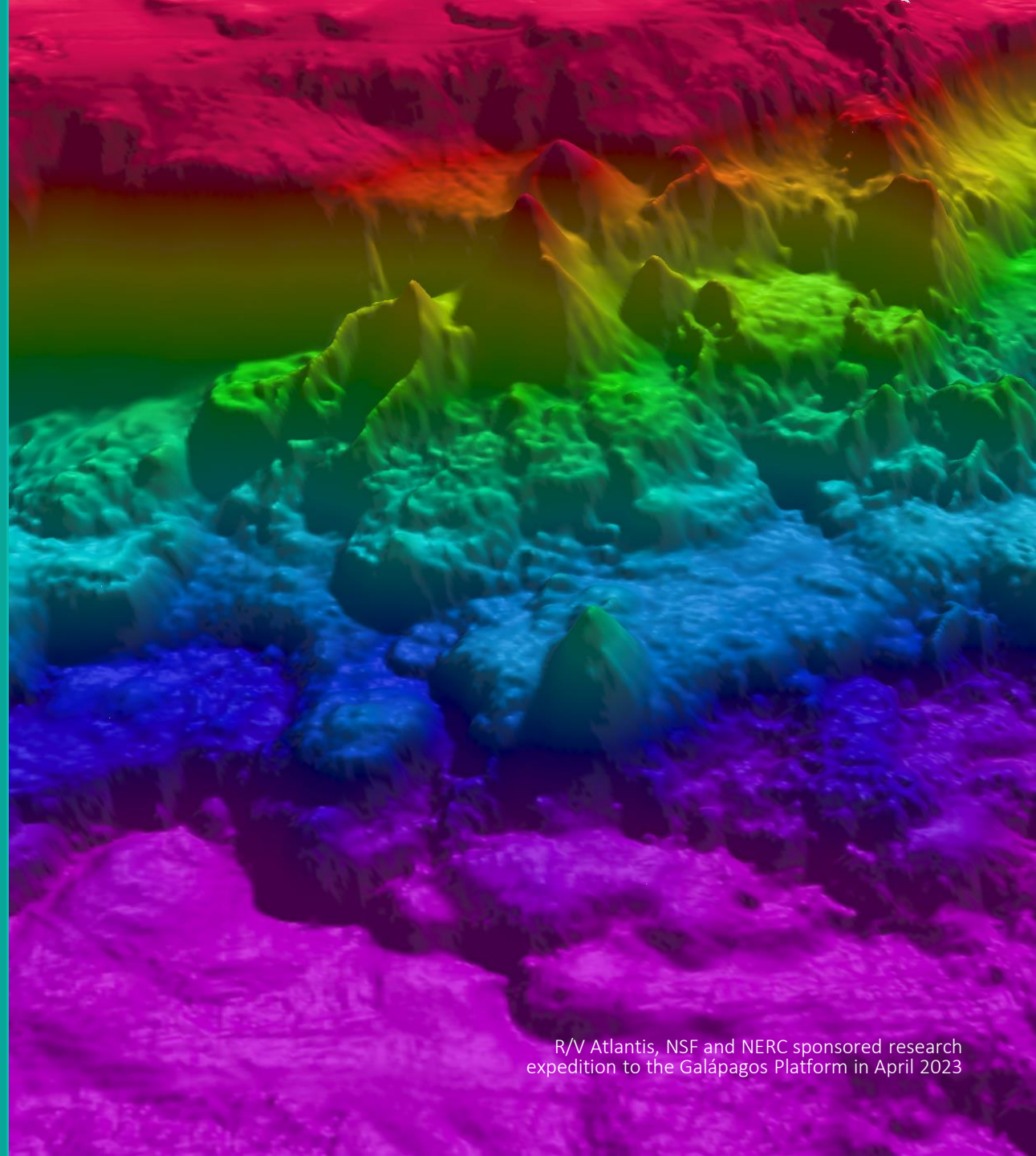
The **Kongsberg Synchronization Unit** can be integrated to coordinate transmissions from multiple echo sounders in order to effectively operate several systems at the same time through a simple but efficient user interface with a real time graphic display that visualizes the sequencing.

The K-Sync works across the range of KONGSBERG products, but also supports echo sounders from other suppliers ensuring synchronization across your entire echo sounder portfolio.

News from the Deep(water EMs)

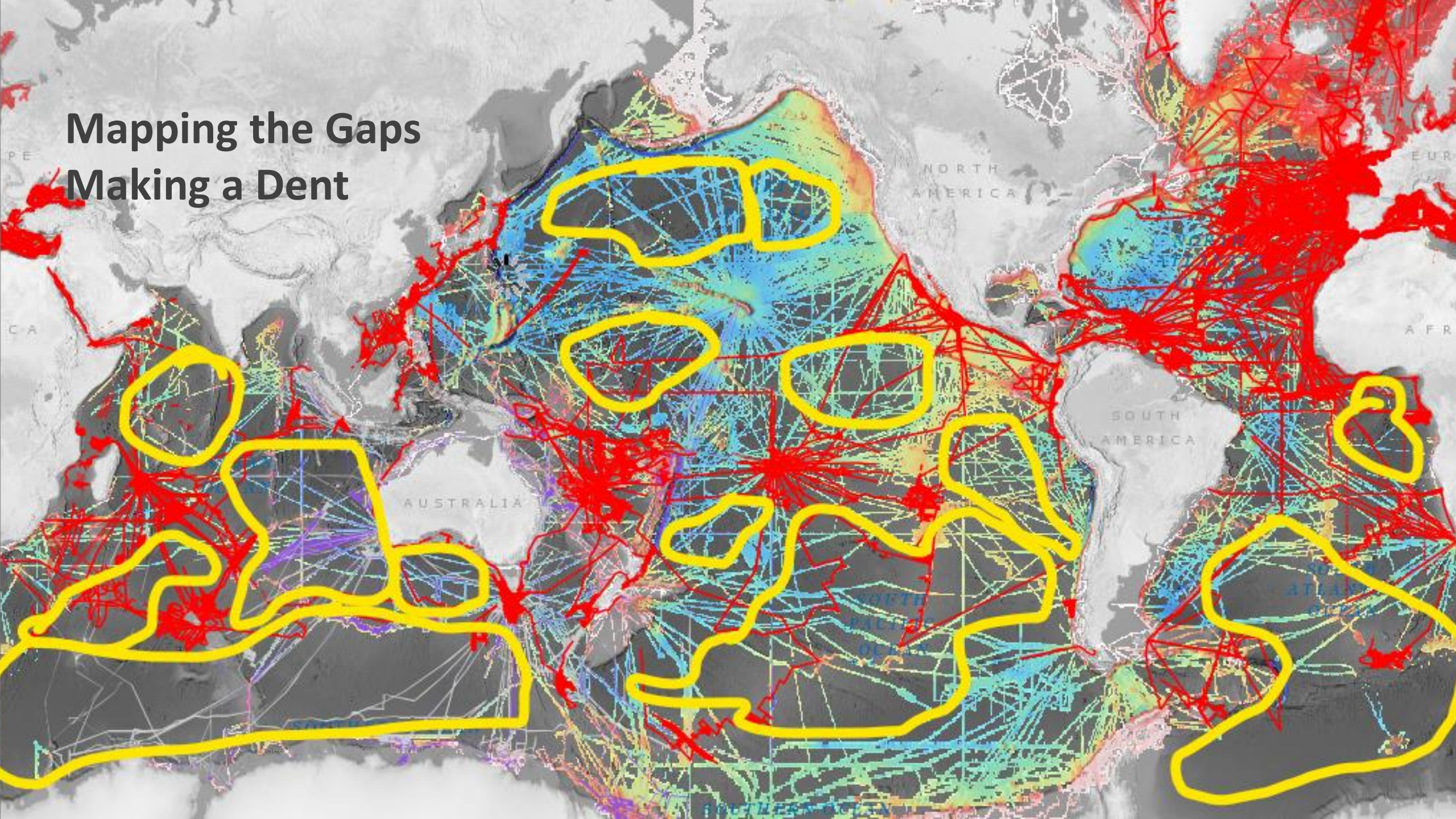
Colleen Peters

KONGSBERG

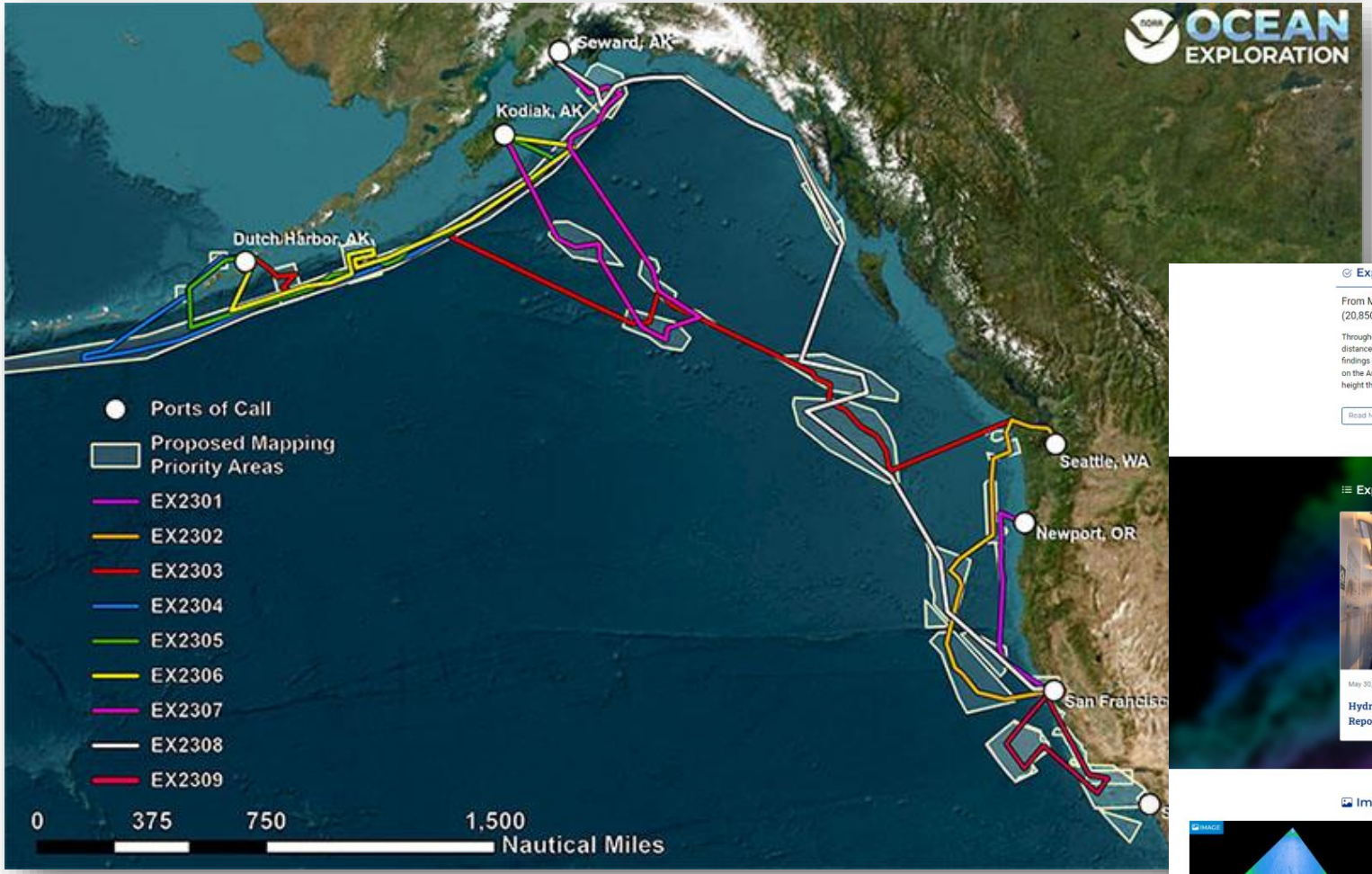


R/V Atlantis, NSF and NERC sponsored research expedition to the Galápagos Platform in April 2023

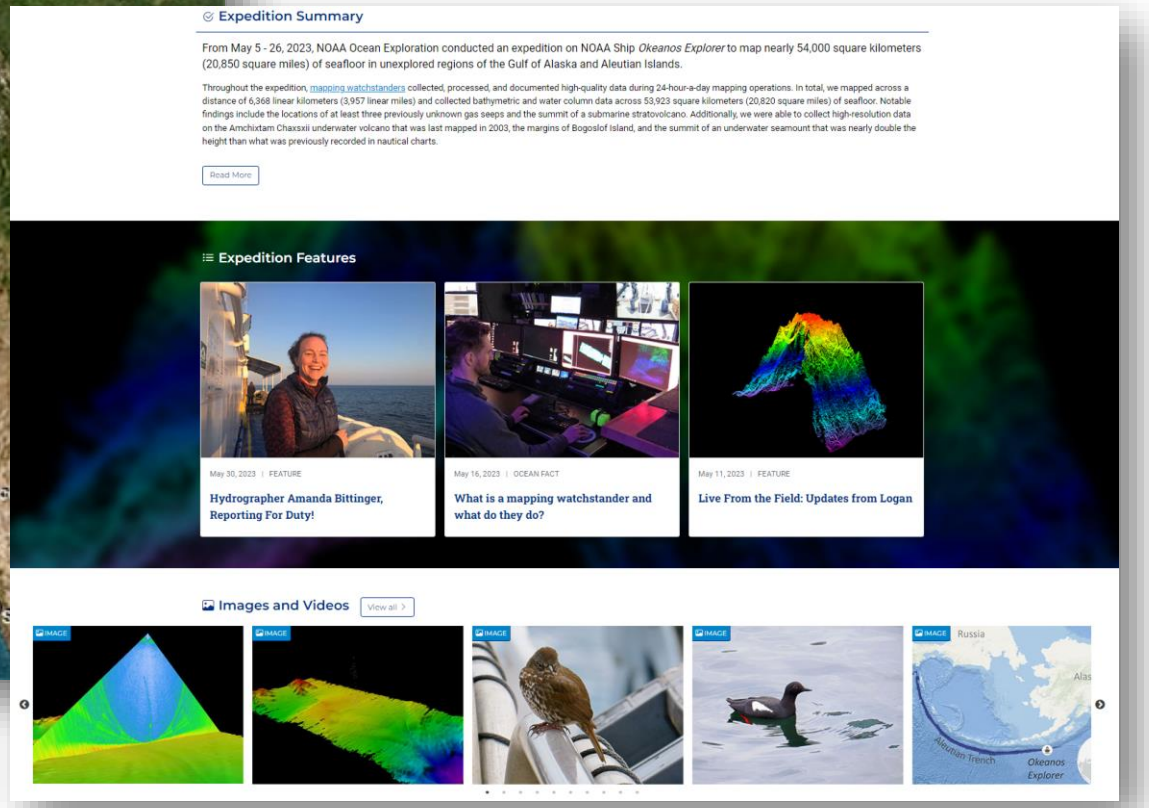
Mapping the Gaps
Making a Dent



NOAA Ship Okeanos Explorer



- Over 160 days at sea on NOAA Ship *Okeanos Explorer* while exploring the waters off the U.S. west coast and Alaska.
- 54,000 sq km mapped – 1 cruise!



Schmidt Ocean Institute

RV Falkor (too)

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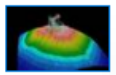
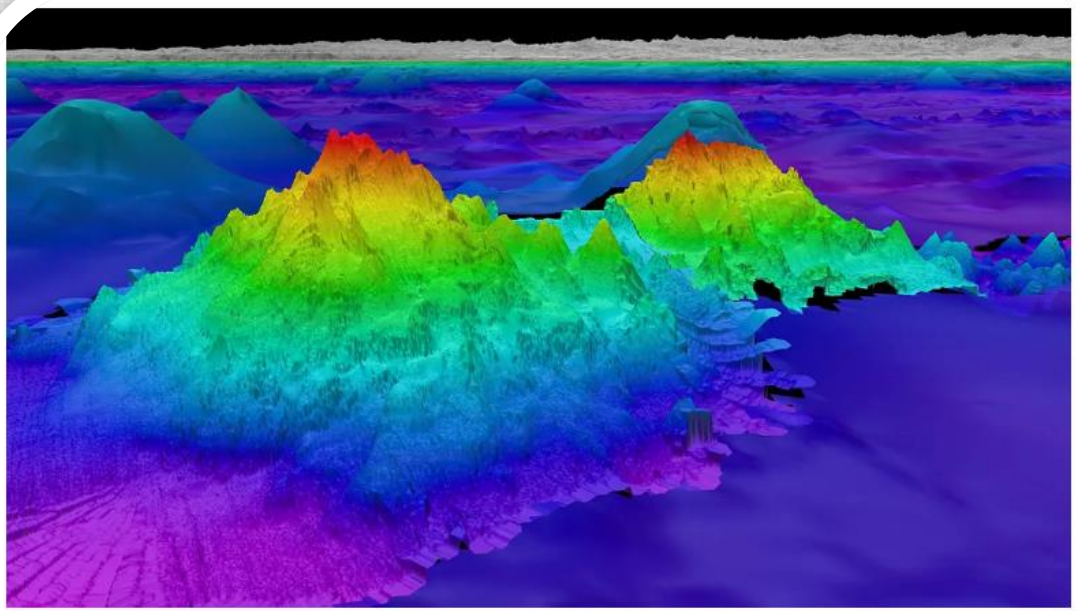
Greg Trauthwein, Editor
Gregory R. Trauthwein has covered the global maritime market for more than 25...

September 19, 2023

SOI Steps Ahead on Ocean Mapping

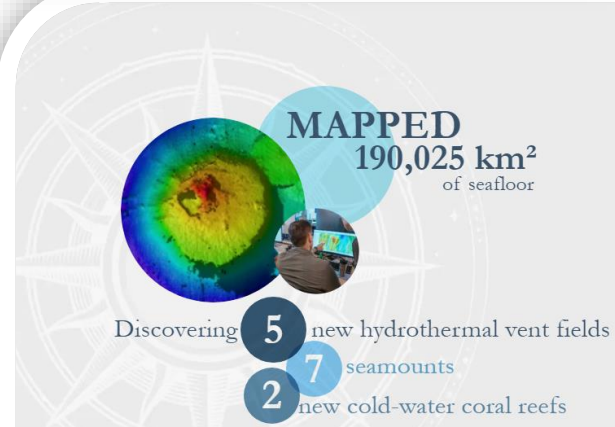


With its new research vessel Falkor (too), Schmidt Ocean Institute (SOI) has ramped up its ability to map the ocean floor. Jyotika I. Virmani, Ph.D. Executive Director, SOI, offers insights on how new and emerging meld with onboard and



The largest of four seamounts recently discovered by Schmidt Ocean Institute's R/V *Falkor (too)* is 2,681 meters tall and covers 450 square kilometers.
Credit: Schmidt Ocean Institute, CC BY-NC-SA 4.0

FALKOR (too) underwent refit in a Spanish shipyard for 17 months; a much bigger ship than Falkor with loads of new room, labs, and potential to expand.
Photos courtesy SOI

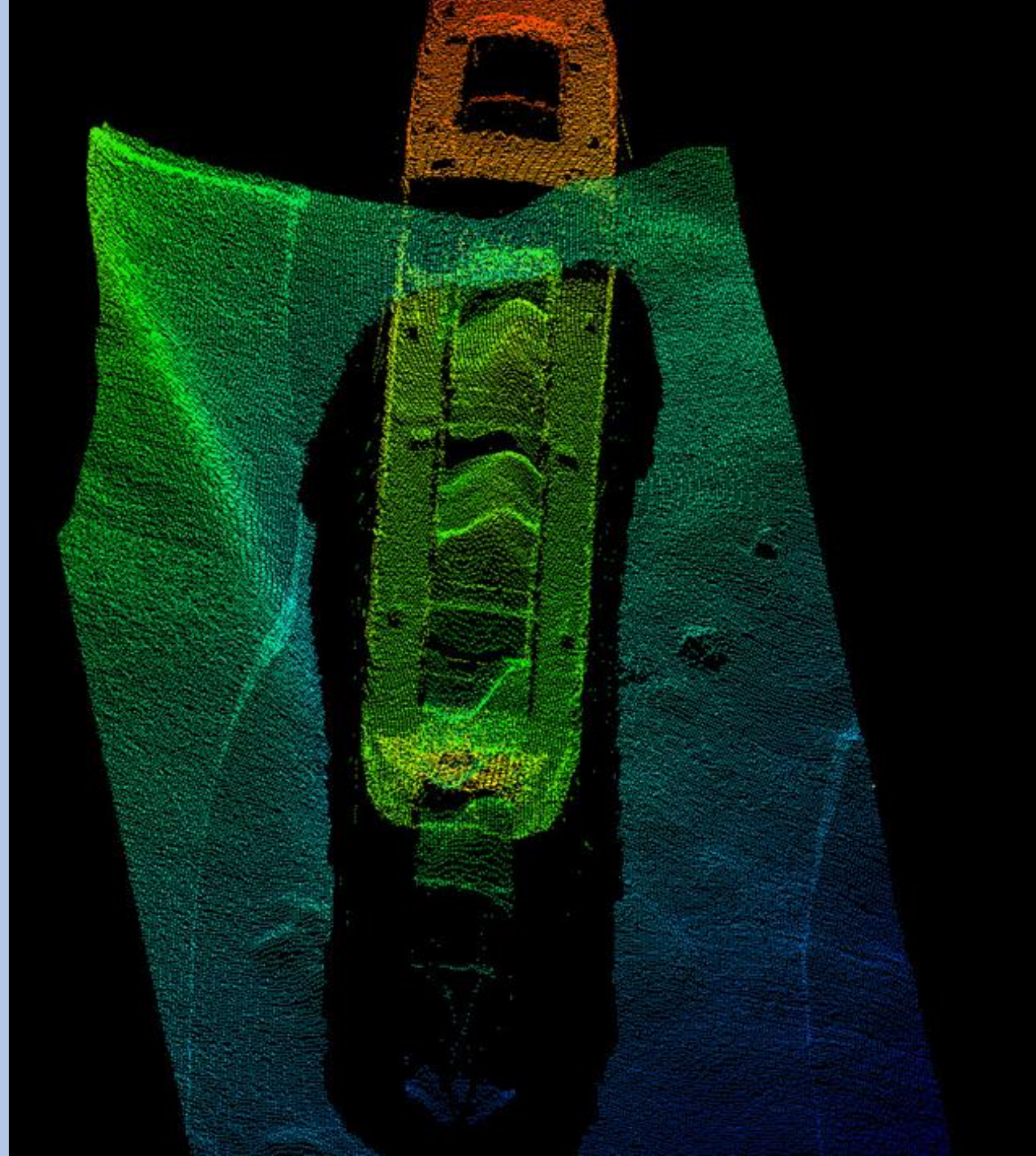


KONGSBERG

New product launch

New product from Discovery: EM2042 – Very high resolution shallow water MBES

- **Key features**
- 150 – 700 kHz frequency range
- Range 0,5m – 600m
- Swath width 170° SRX/220° DRX
- Sector transmitting, 3 sectors
- True 3-sector, real-time stabilization roll/pitch/yaw
- Near field focusing on TX and RX



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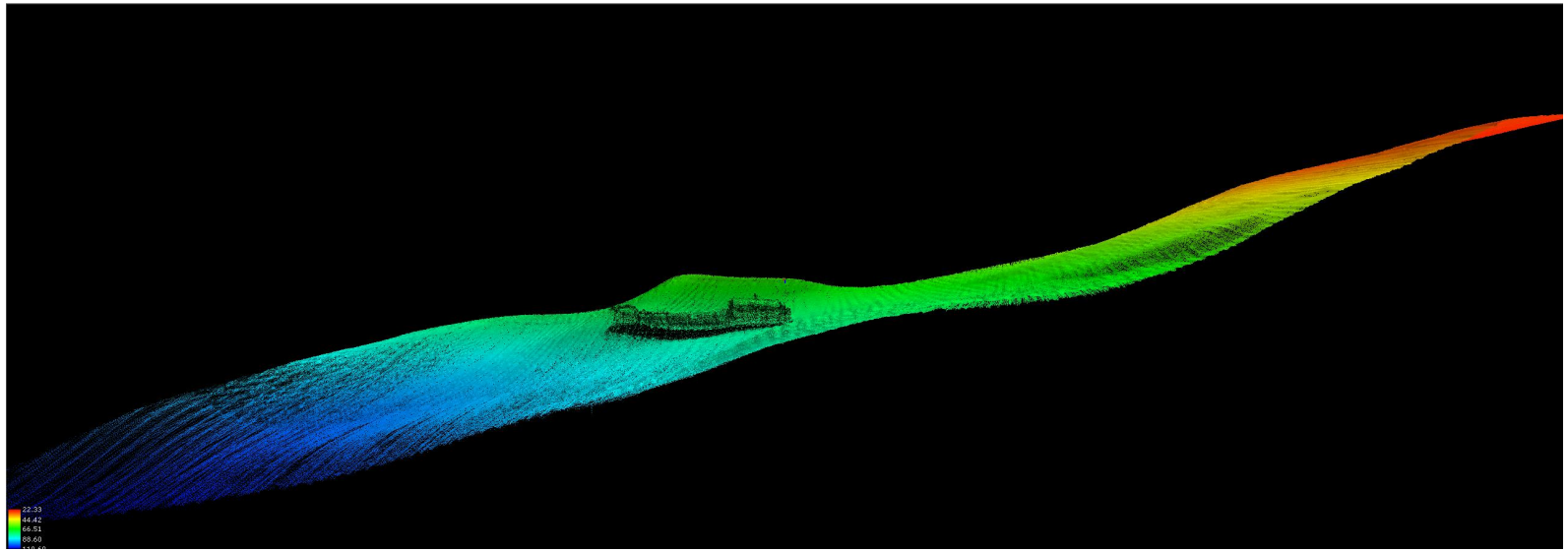
EM® 2042 vs EM® 2040

Very high-resolution shallow water MBES

Main differences

- Complete new design
- 50m depth rated, no export license
- >60% weight reduction
- Less power consumption
- Up to 4096 beams per ping
- Emebedded (option):
  - ✓ miniMRU
  - ✓ SVT
- Ready for (option):
  - ✓ QuadSwath™
  - ✓ PredictivePitch™

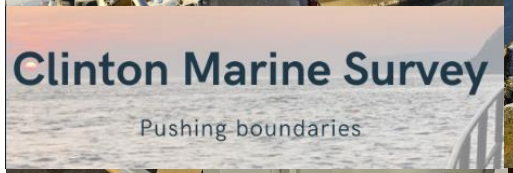


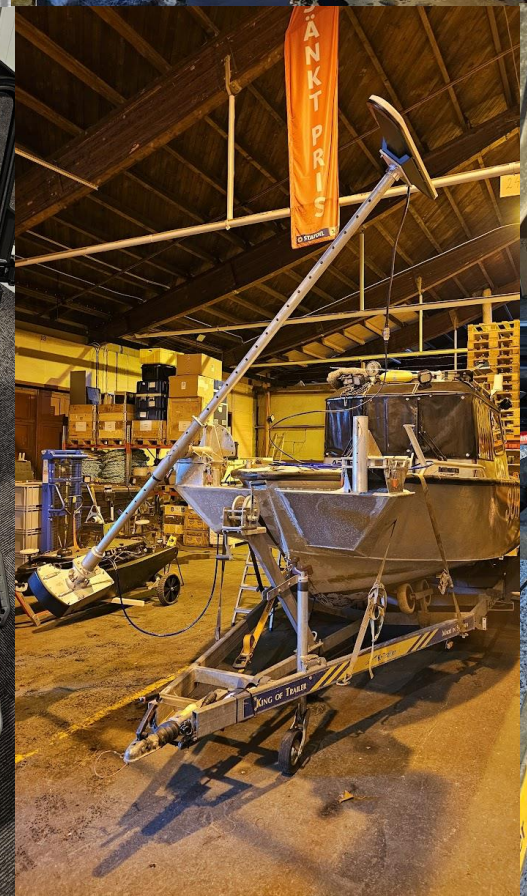
- One cable to the topside (SRX w/embedded miniMRU/SVT)
- EM 2040 still in production – no EOL announced

EM 2042 UPDATES

First EM 2042 delivered to pilot customer

- Clinton Marine Survey (Gothenburg, Sweden), JAN 2024
- EM 2042 07 SRX + Seapath 130 + PPU + Portable Plate
- Testing of :
  - Usability , endurance and robustness
  - Performance
  - Evaluation of new features
  - Comparison against other shallow water MBES





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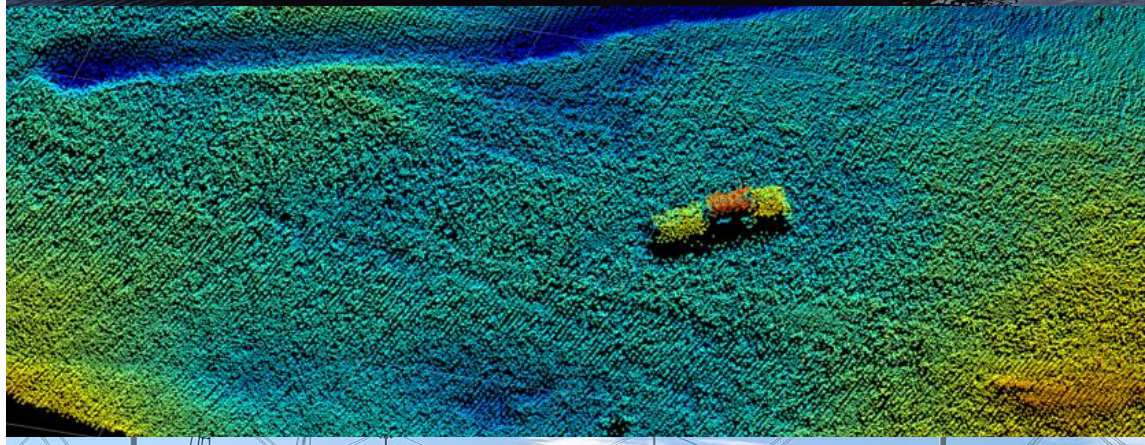
EM 2042 UPDATES: DEMOS

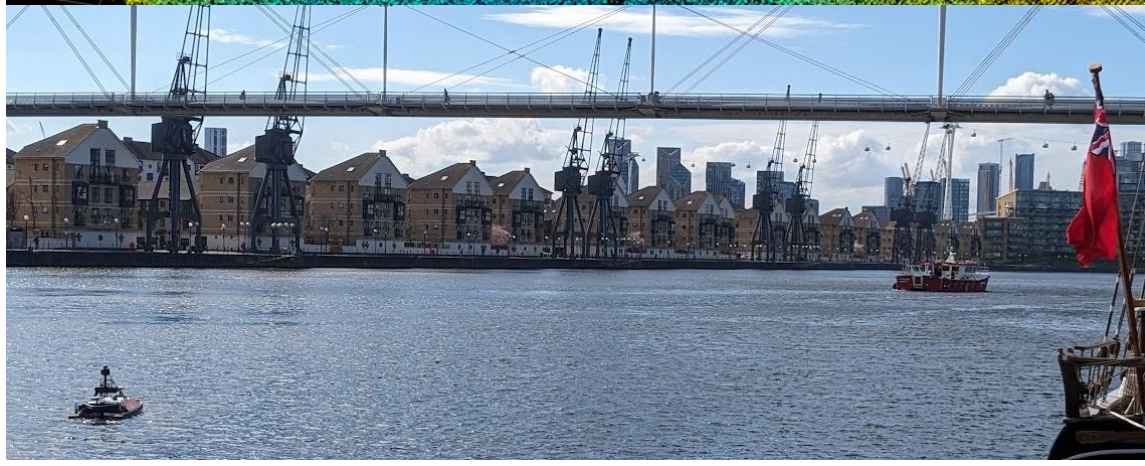
- First public demo:
  - Oceanology March 2024 (London), aboard Fugro Explorer

- Horten (Norway).
  - Unit mounted on “Pingeline”
  - Ongoing integration on USV from Maritime Robotics. One “Otter Pro” vehicle to be soon available for testing and demos

- CSL Heron – University of New Brunswick
  - John Hughes-Clark’s 2024 field programs this month testing on CSL Heron, results were that raw data were very clean

- DEMO systems are available worldwide upon request





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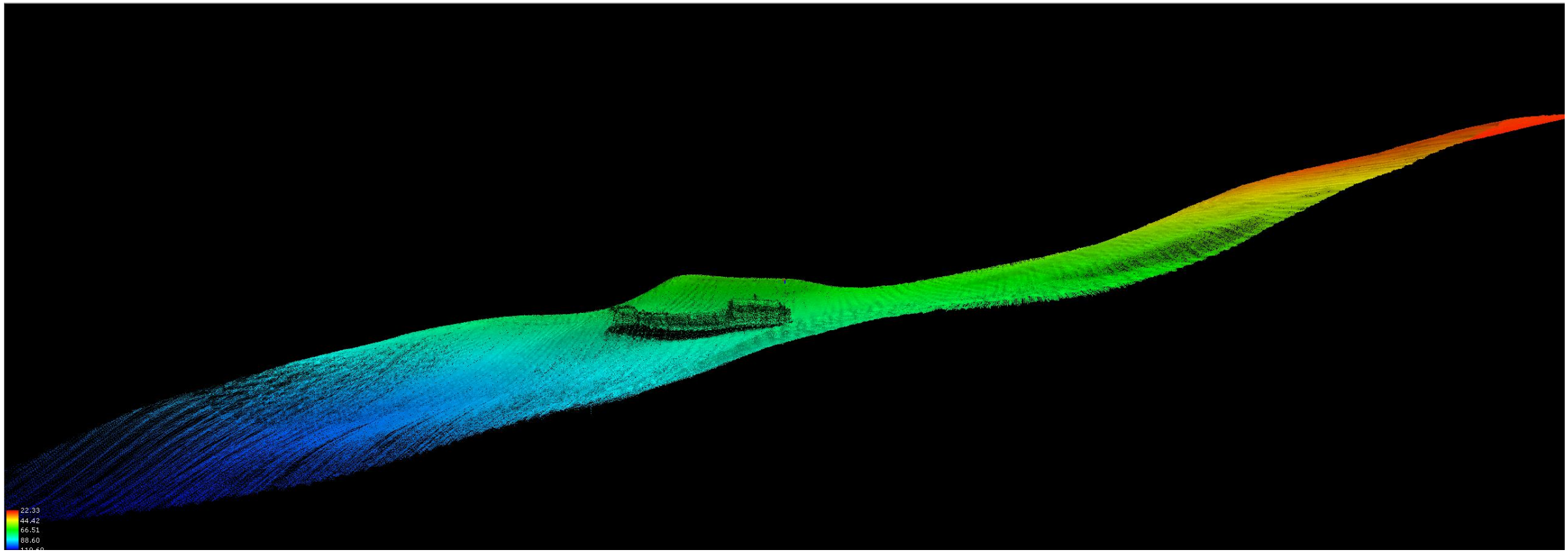
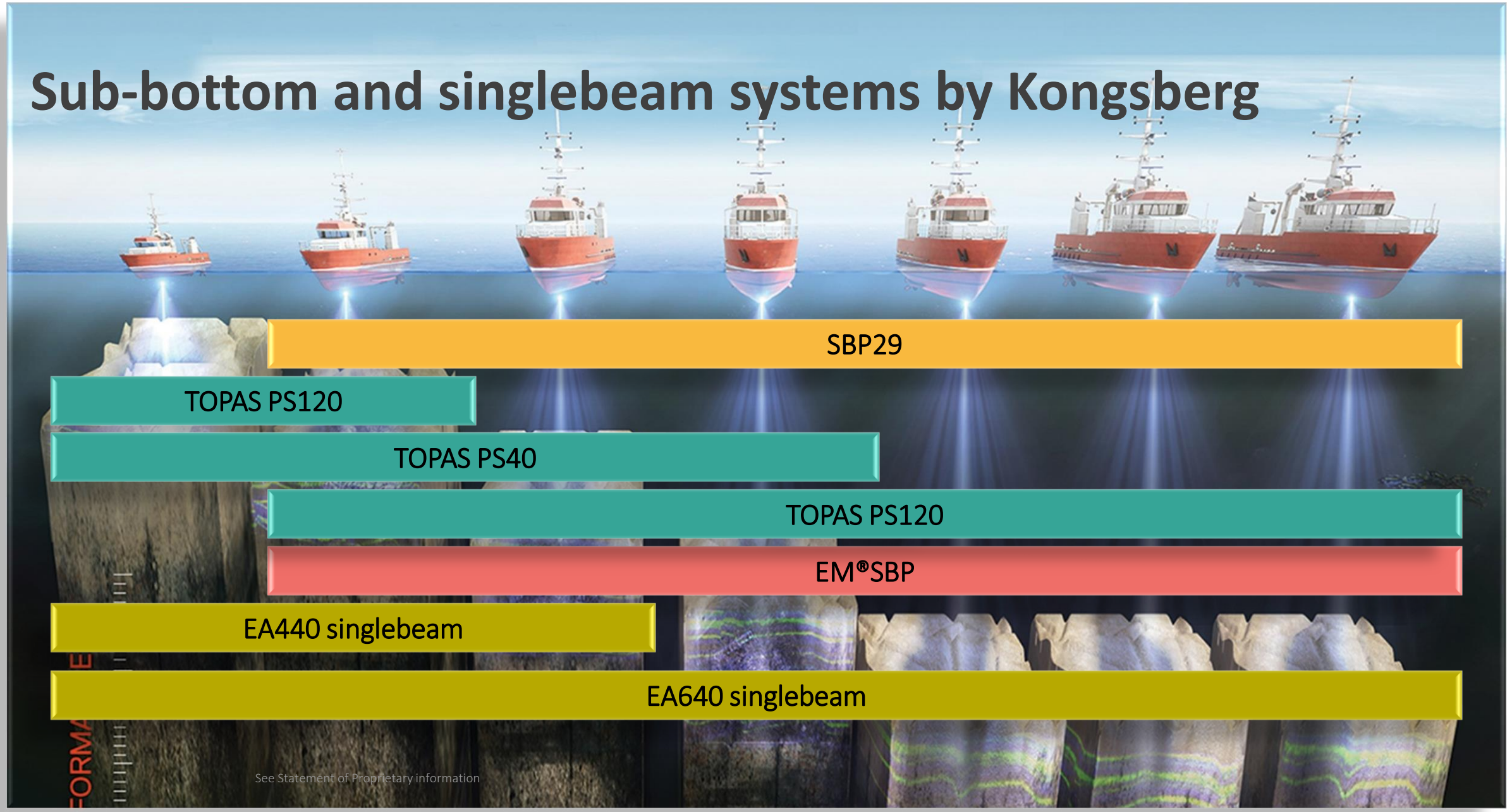
EM 2042

- EM 2040 family will continue to be produced and supported, no EOL has been announced
- Upgrade path from EM 2040 available - Mounting plate required to adapt new smaller tranducers to EM 2040 transducer footprints

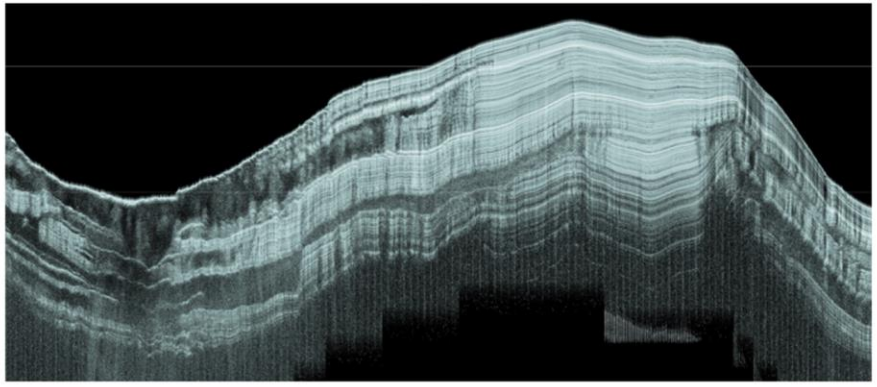


Sub-bottom and singlebeam systems by Kongsberg



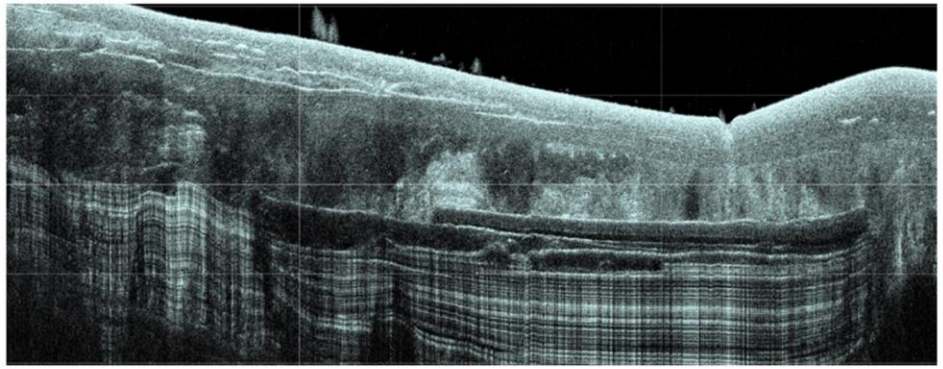
Subbottom Product Family

SBP29



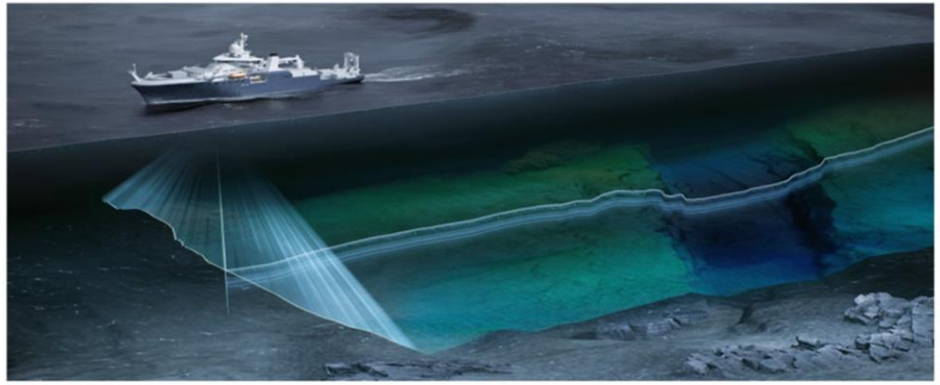
KONGSBERG See Statement of Proprietary Information

TOPAS



KONGSBERG See Statement of Proprietary Information

EM®SBP



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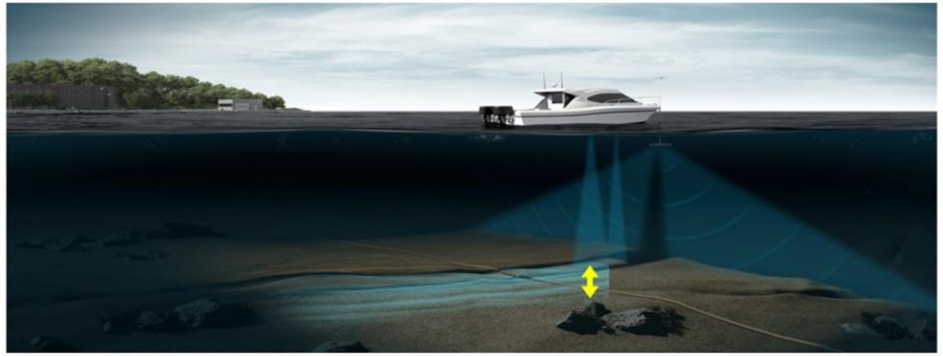
EA 440/640 sub-bottom



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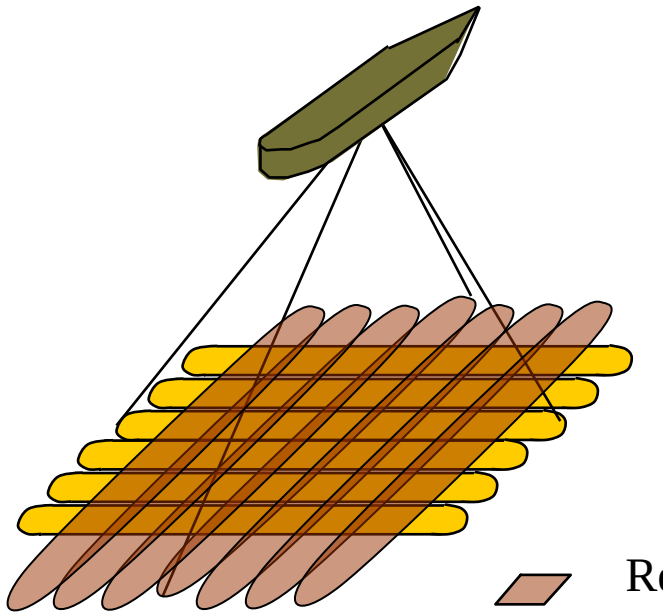
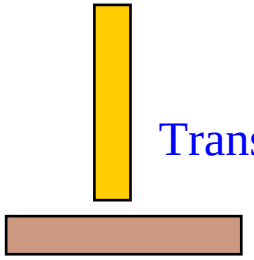
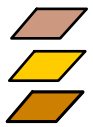
CON

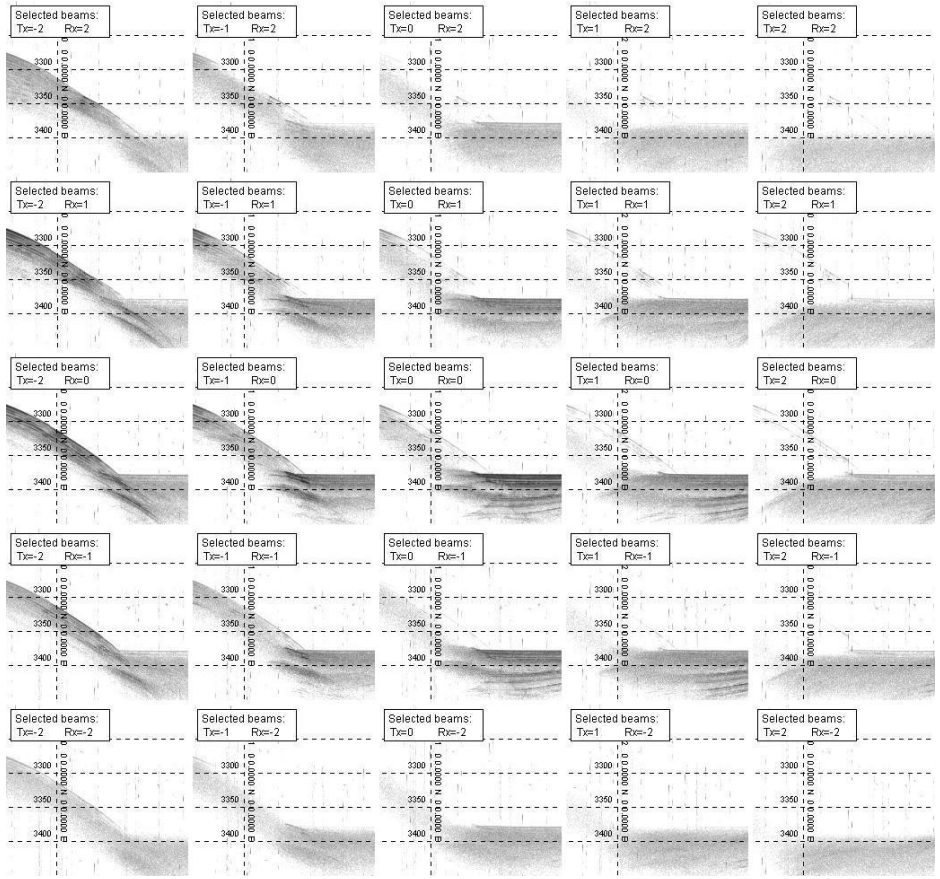
SBP29

Up to 21 footprints across per ping
Cycling tilt, beam width and pulse options
Composite echogram to pick the best

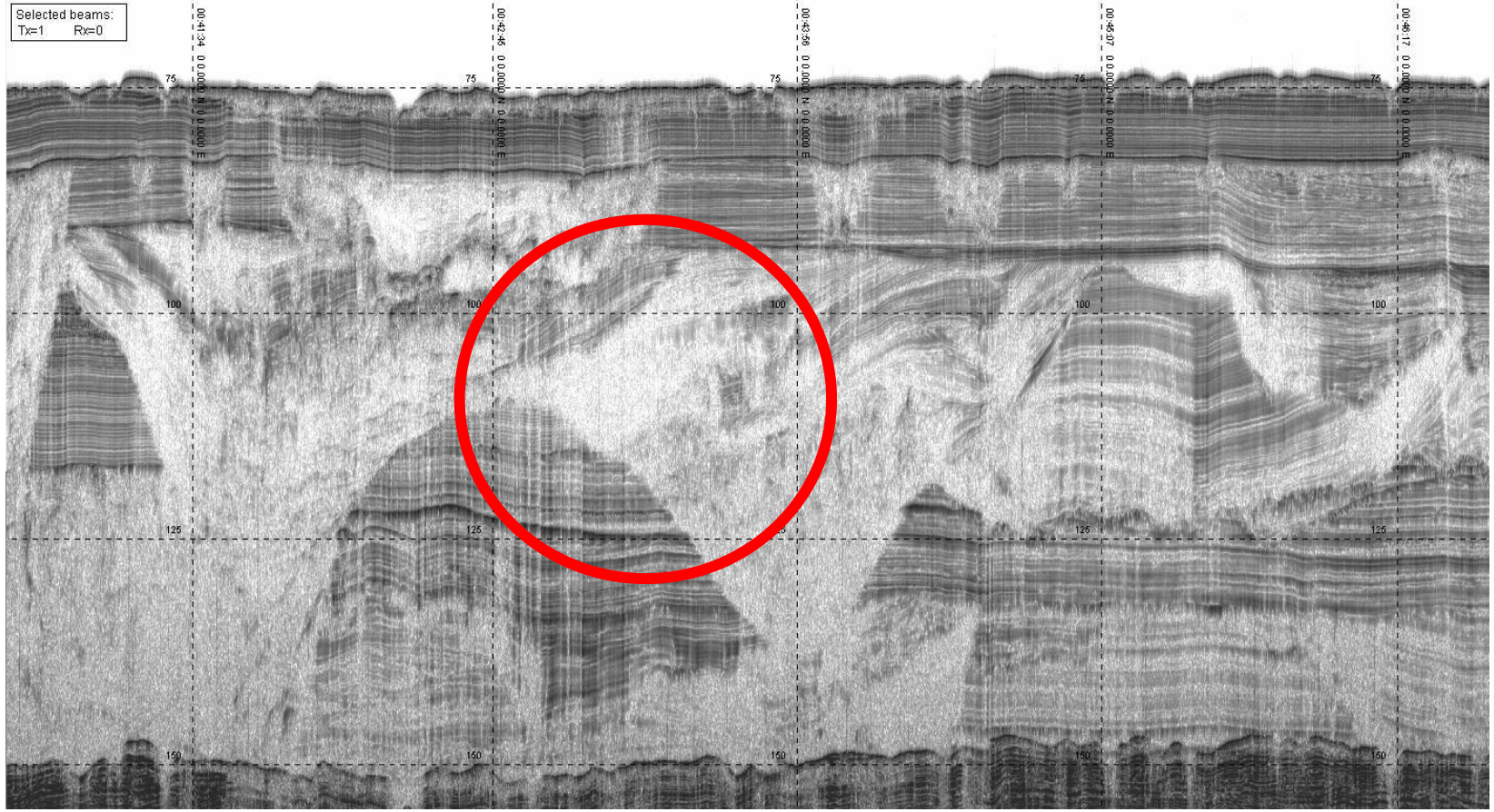






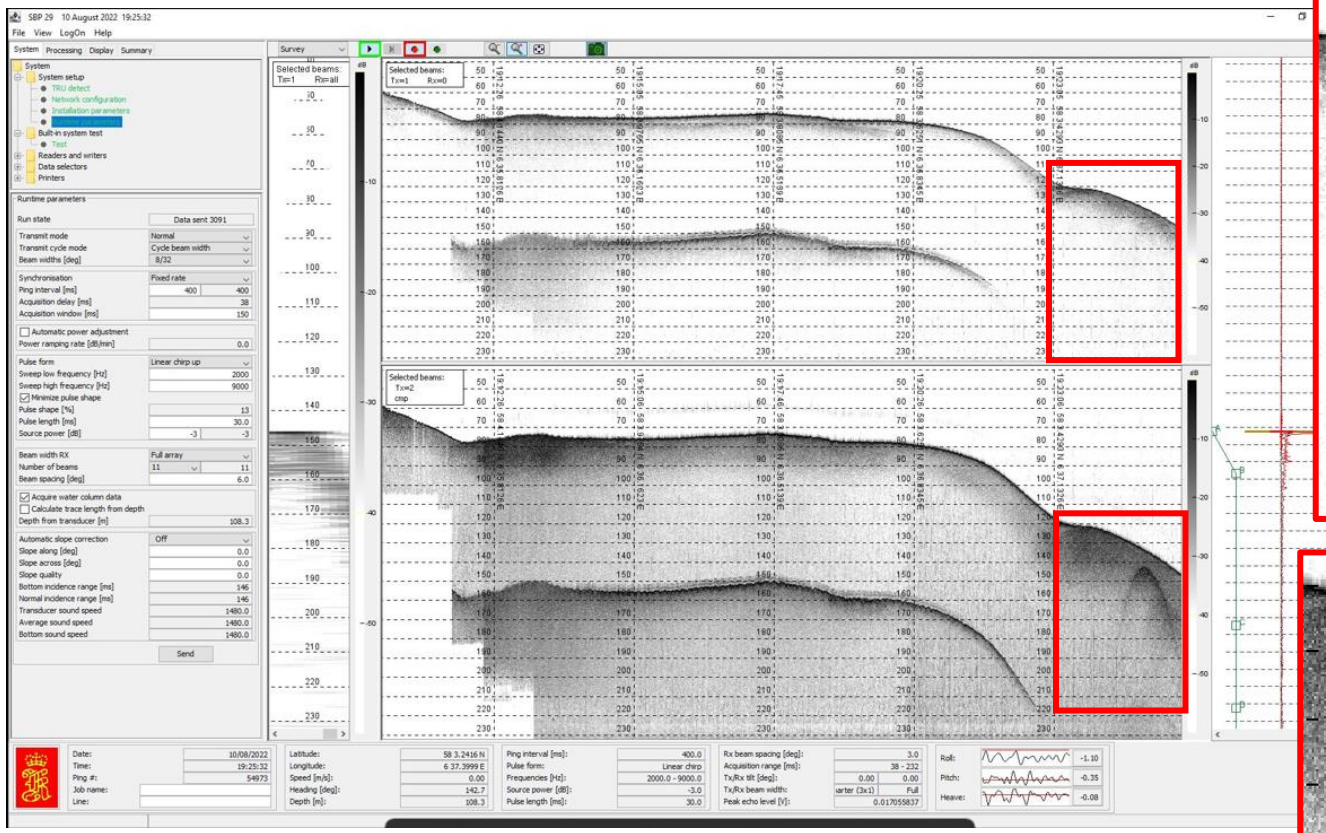


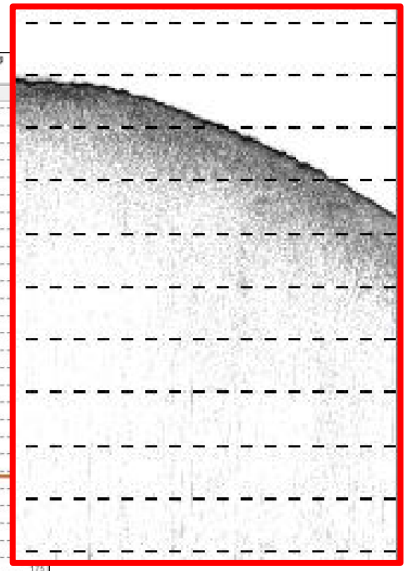
The composite solution

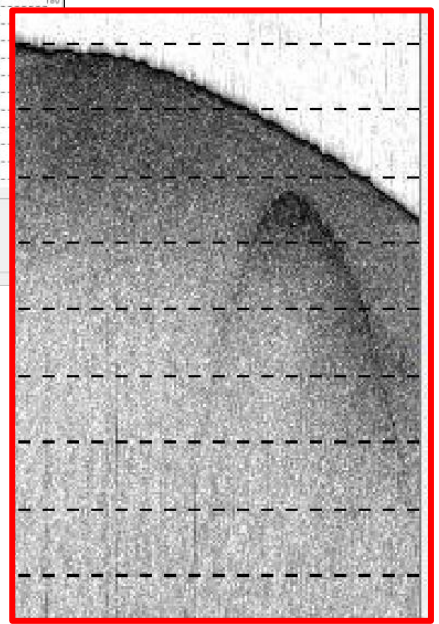


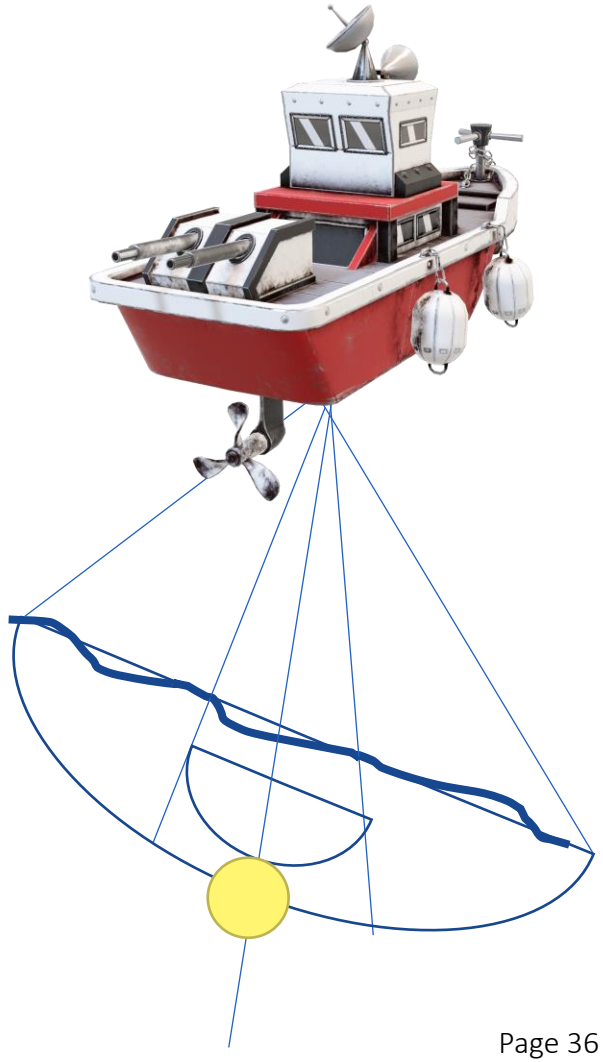
KONGSBERG

The composite echogram for object detection









Echogram 1:
- Narrowest beam (8°)
- RX=0 => Vertical (across)

Echogram 2:
- TX=2 => widest echogram
  - 32 deg in this installation
- cmp=ON
  - Beam width containing the strongest echo
  - The RX beam with the strongest echo
  - Direction is unknown

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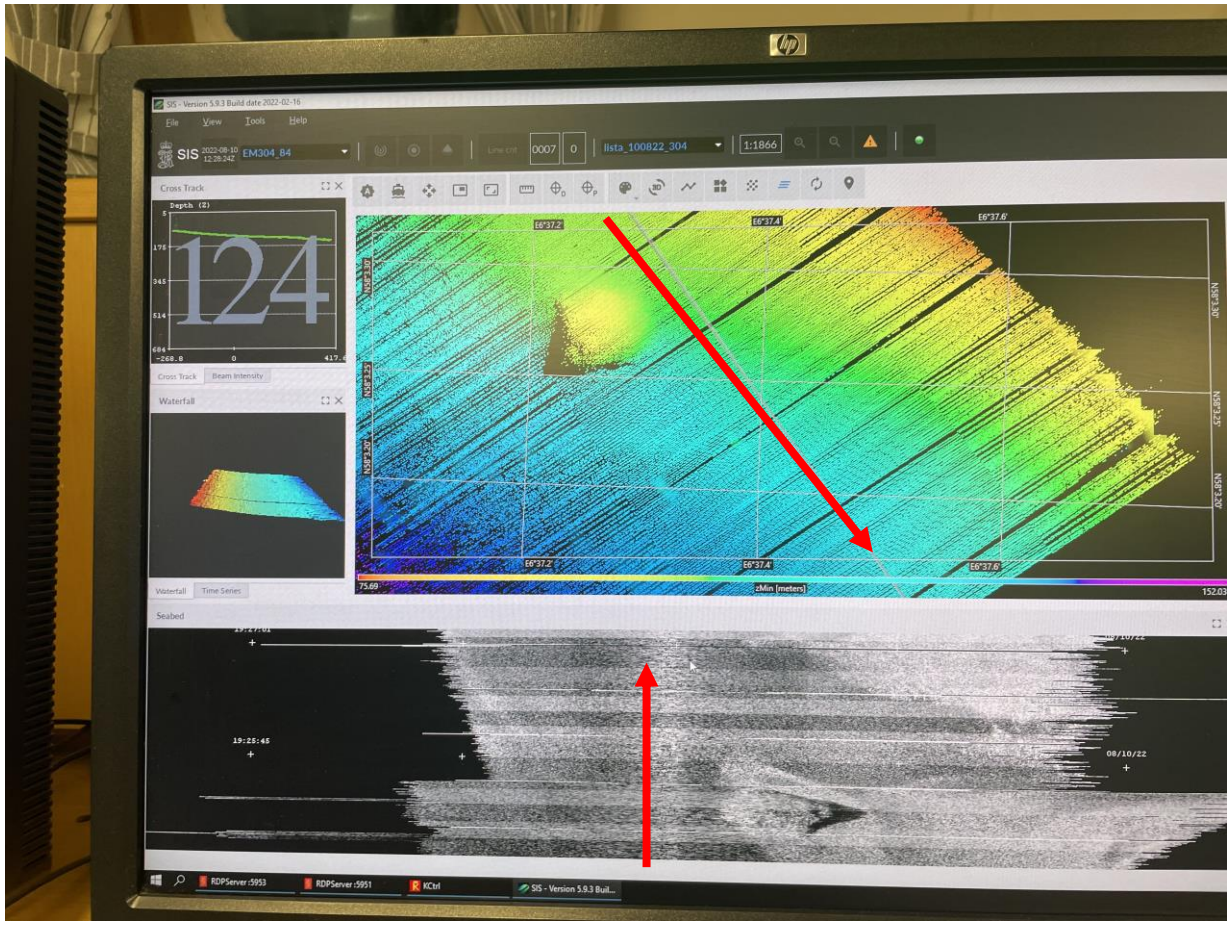
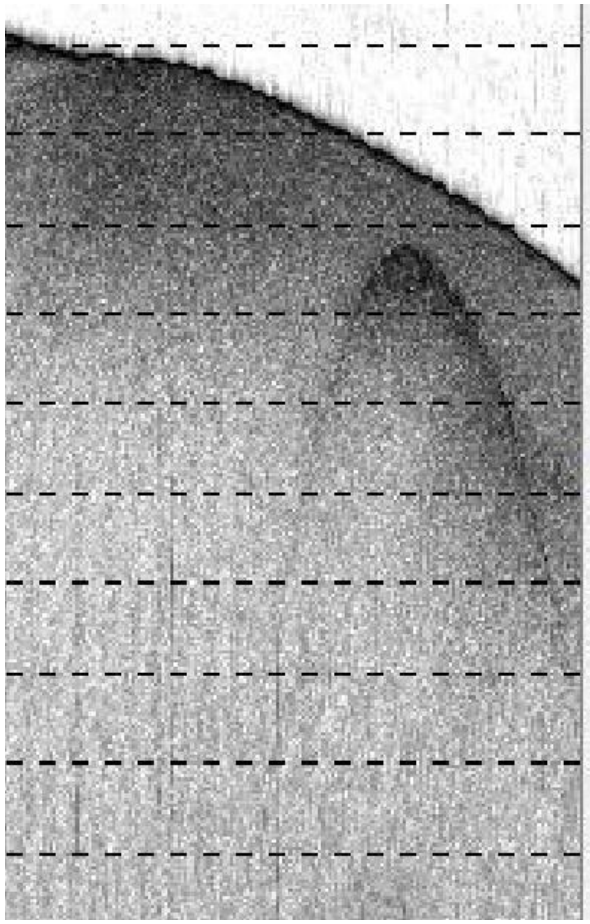
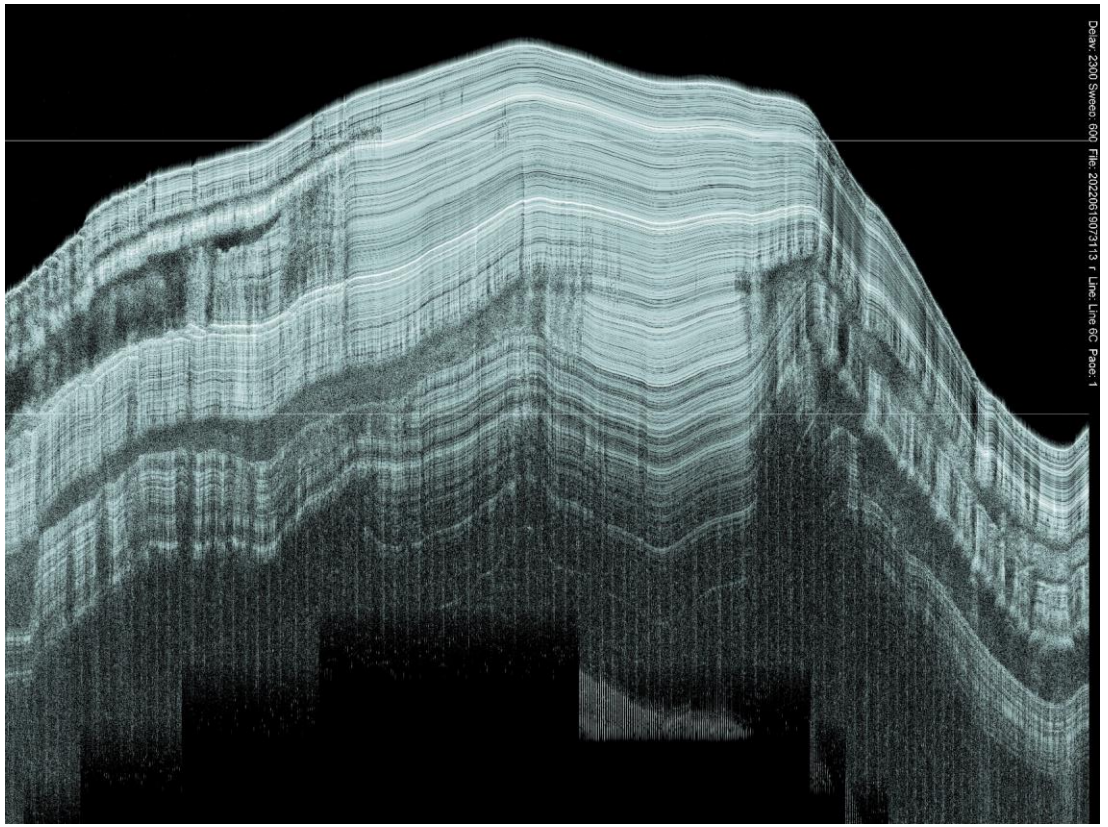

SIS
EM304_84
lista_100822_304
1:1866
Cross Track
124
Waterfall
Seabed
19:25:45
08/10/22



SBP29 Benefits

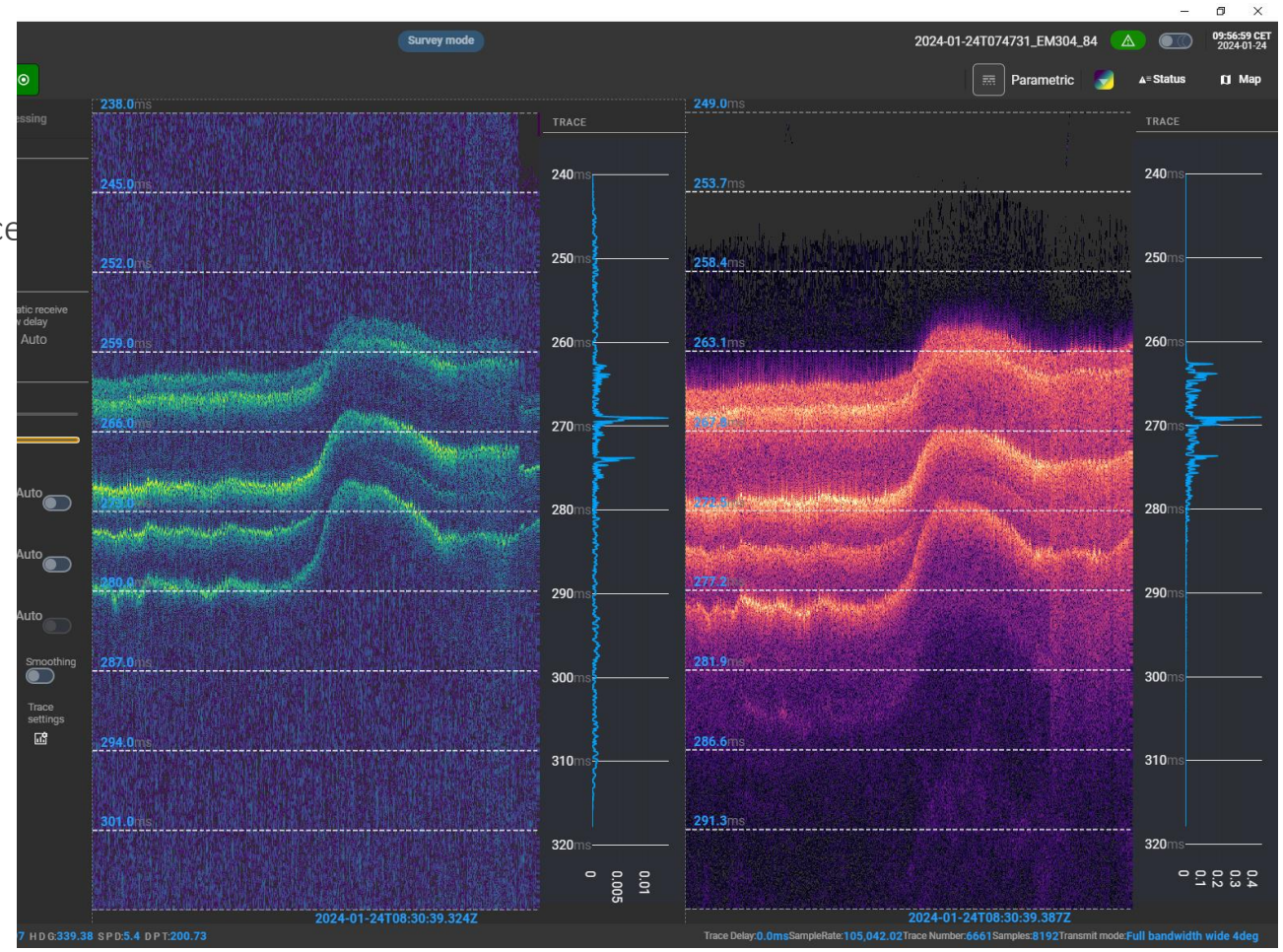
- Best performance
  - Highest source level @sub-bottom frequencies
  - Narrow beams
  - High vertical resolution
- Unique multibeam capabilities with the composite solution
  - Increased slope robustness
- High flexible usage for scientific purposes
  - Raw data logger
  - Wide beams for backscatter studies



EM SBP

Sub-bottom capability with EM 304 and EM 124

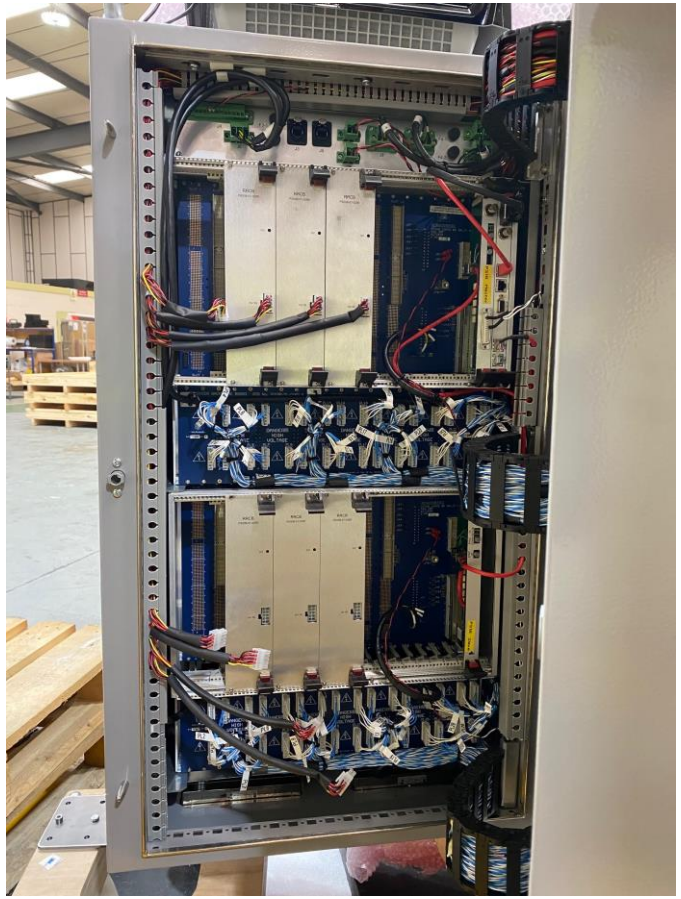
- Add sub-bottom imaging to your EM®304 or EM®124 multibeam survey without any extra hardware
- Sub-bottom or multibeam pinging at your selectable sequence
- Useful for platforms that cannot install more transducers
- Simultaneous imaging by both primary frequency and parametric signal
- Licensed software package run on a separate computer
- → ~30m penetration in ~230m water →

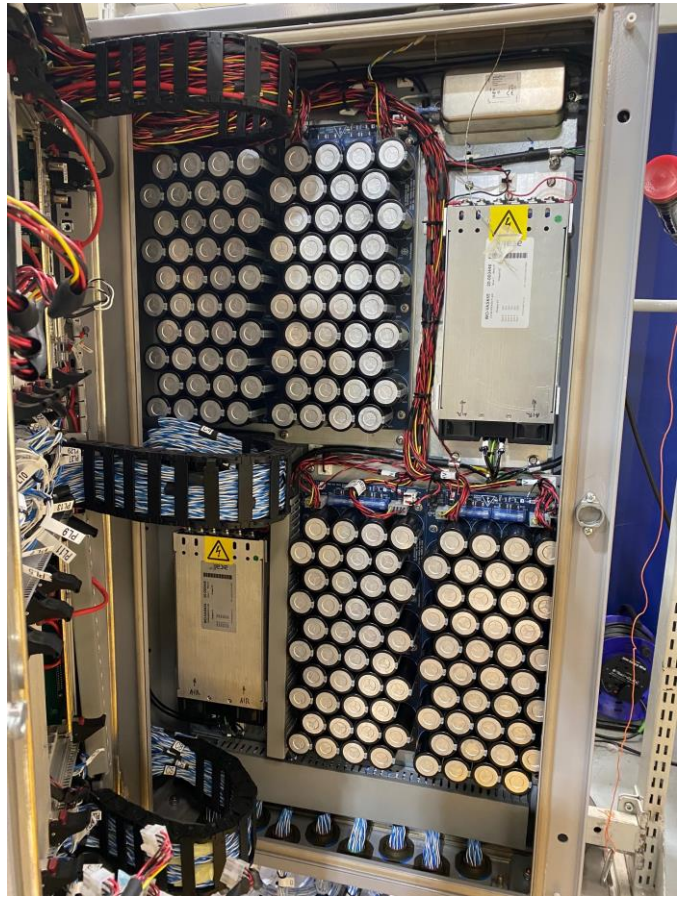


Development project – TOPAS PS18 mk3

- Necessary EOL redesign
- New Transceiver unit
- New transducer elements
- Same form/fit as current version
- TRX electronics developed, maintained and delivered by KD
- System build and delivered by Geo Acoustics
- Transducers by Neptune

- Static testing and sea trials in Horten from Q3-24





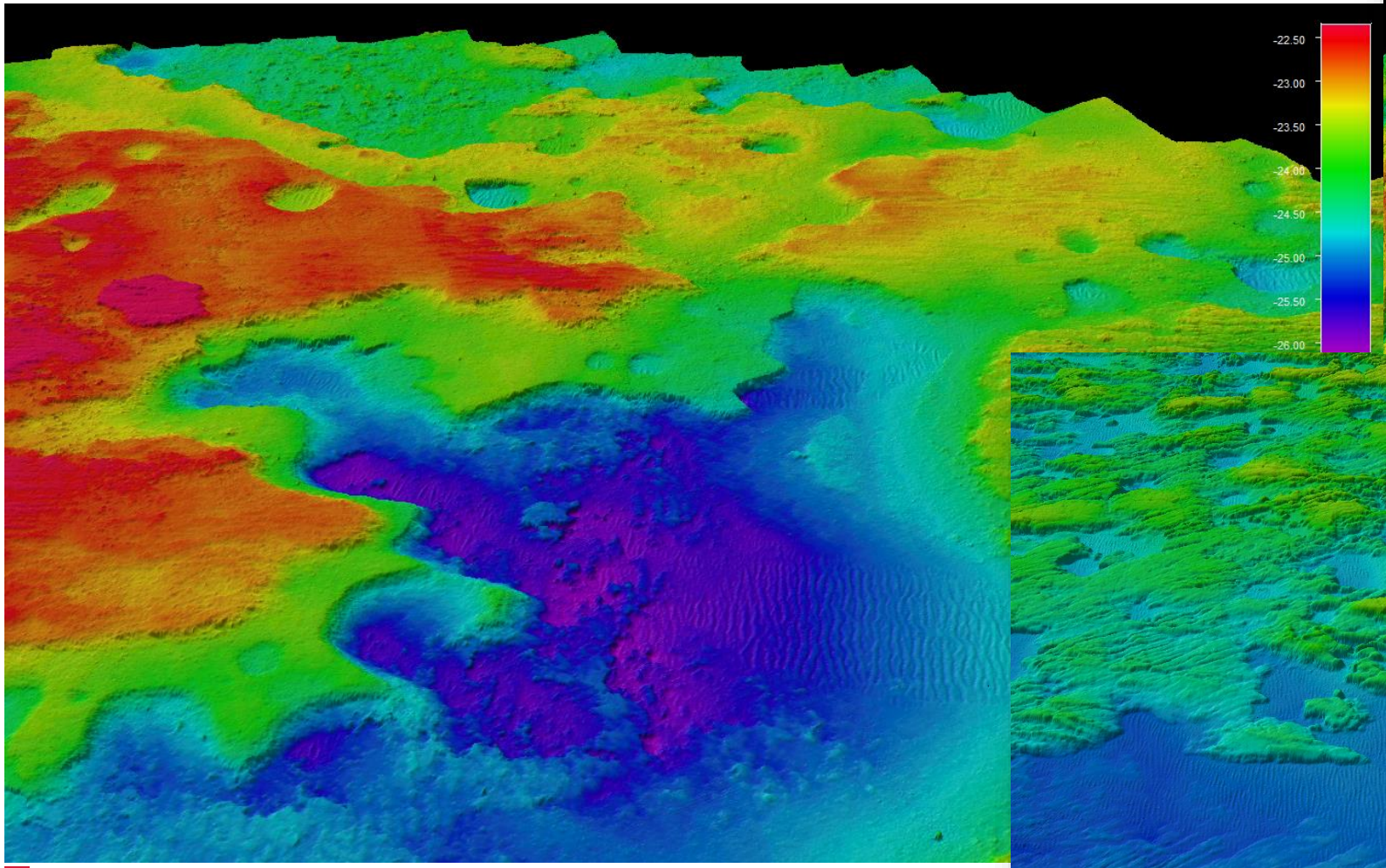
Using Uncrewed Surface Vehicles for

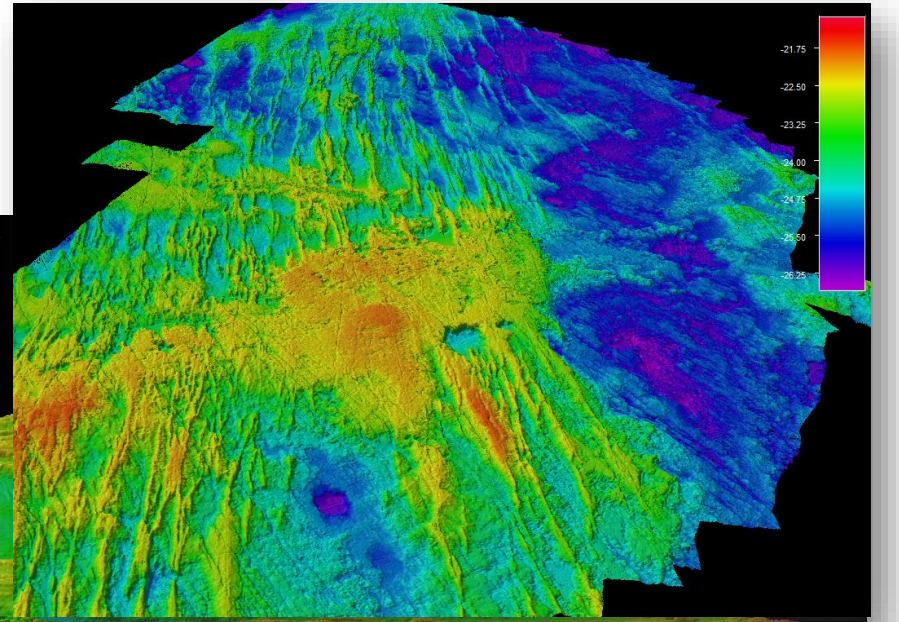
Remote Mapping

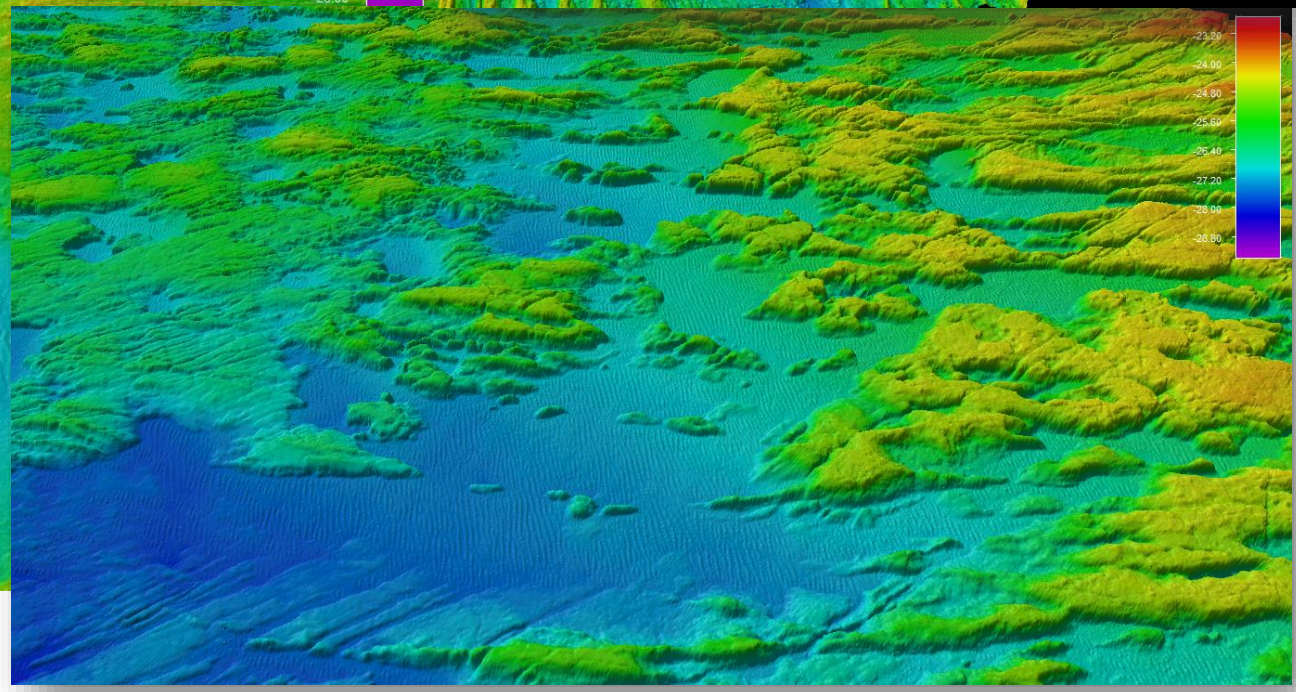
Saildrone, UNH, OECI

Courtesy of Exail, France

EM2040-07 SRX DS on Exail DriX-8 USV







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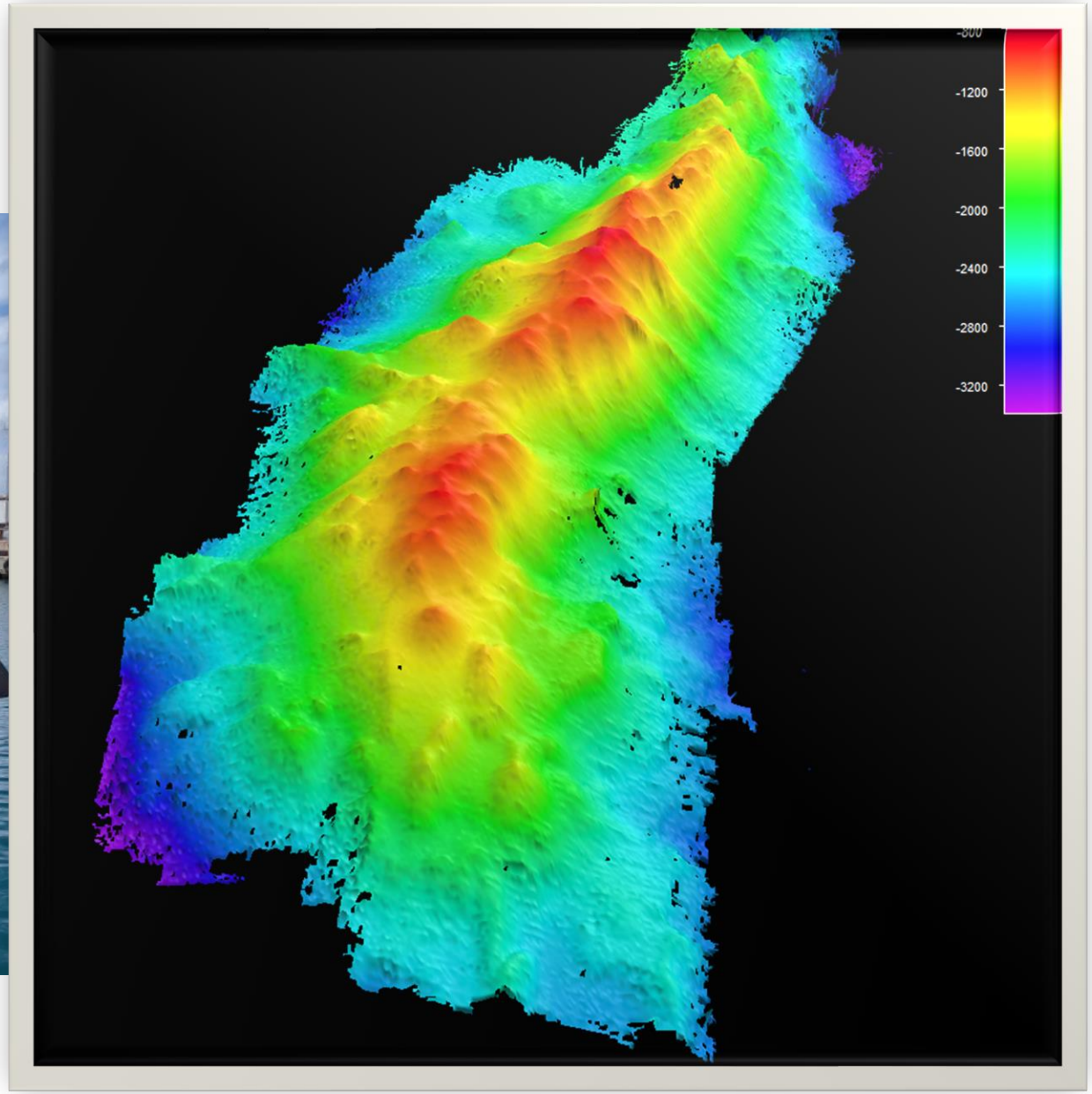
University of New Hampshire

EM712 on Exail DriX-8 USV

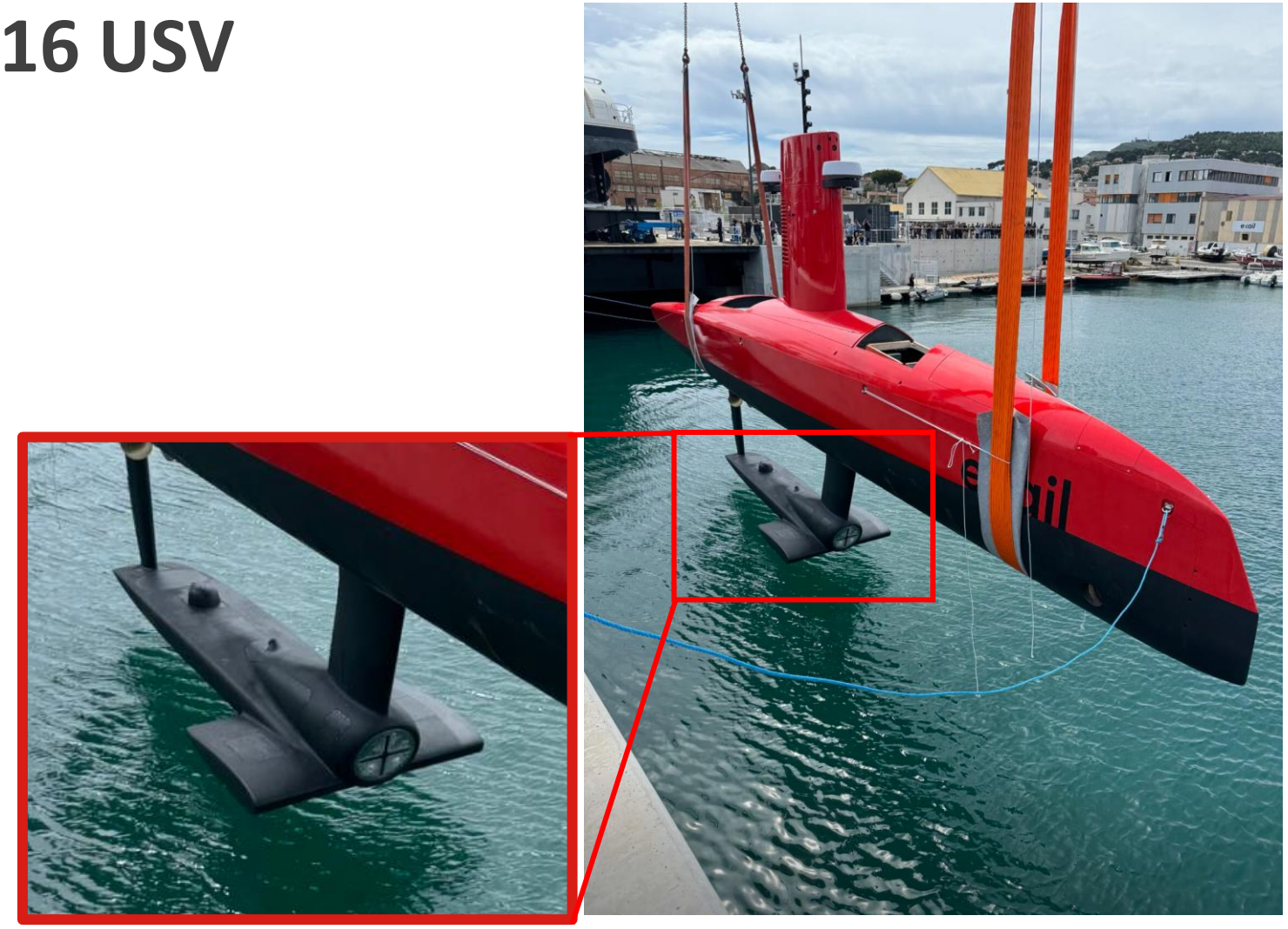


Full depth mapping

EM304 on Exail DriX O-16 USV

- 2500nm range
- 30 days endurance
- Hybrid propulsion
- Remotely operated vehicles (ROV)
- Remotely operated towed vehicles (ROTV)
- Autonomous underwater vehicles (AUV)

- Deepwater EM 304 MKII MBES
- SBP
- USBL



Courtesy of Exail, France

First production

EM304 MKII

- EM304 MKII and EM2040
- Currently 5 systems in operation or being installed
- 6th system requested
- Projected to receive the first EM304 DC system.

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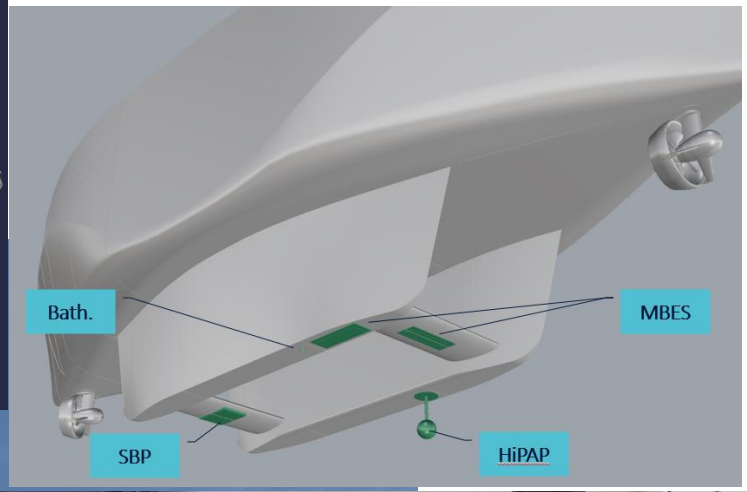
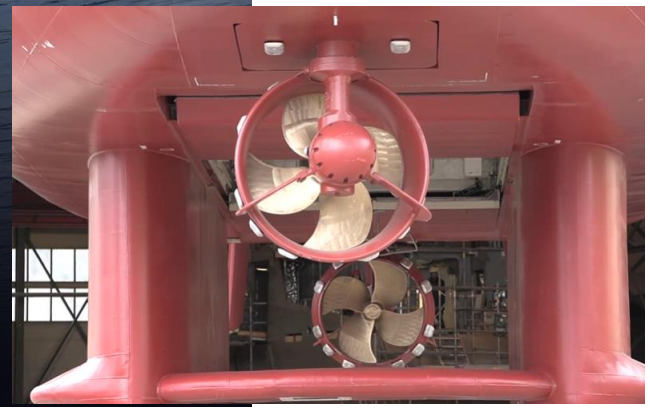


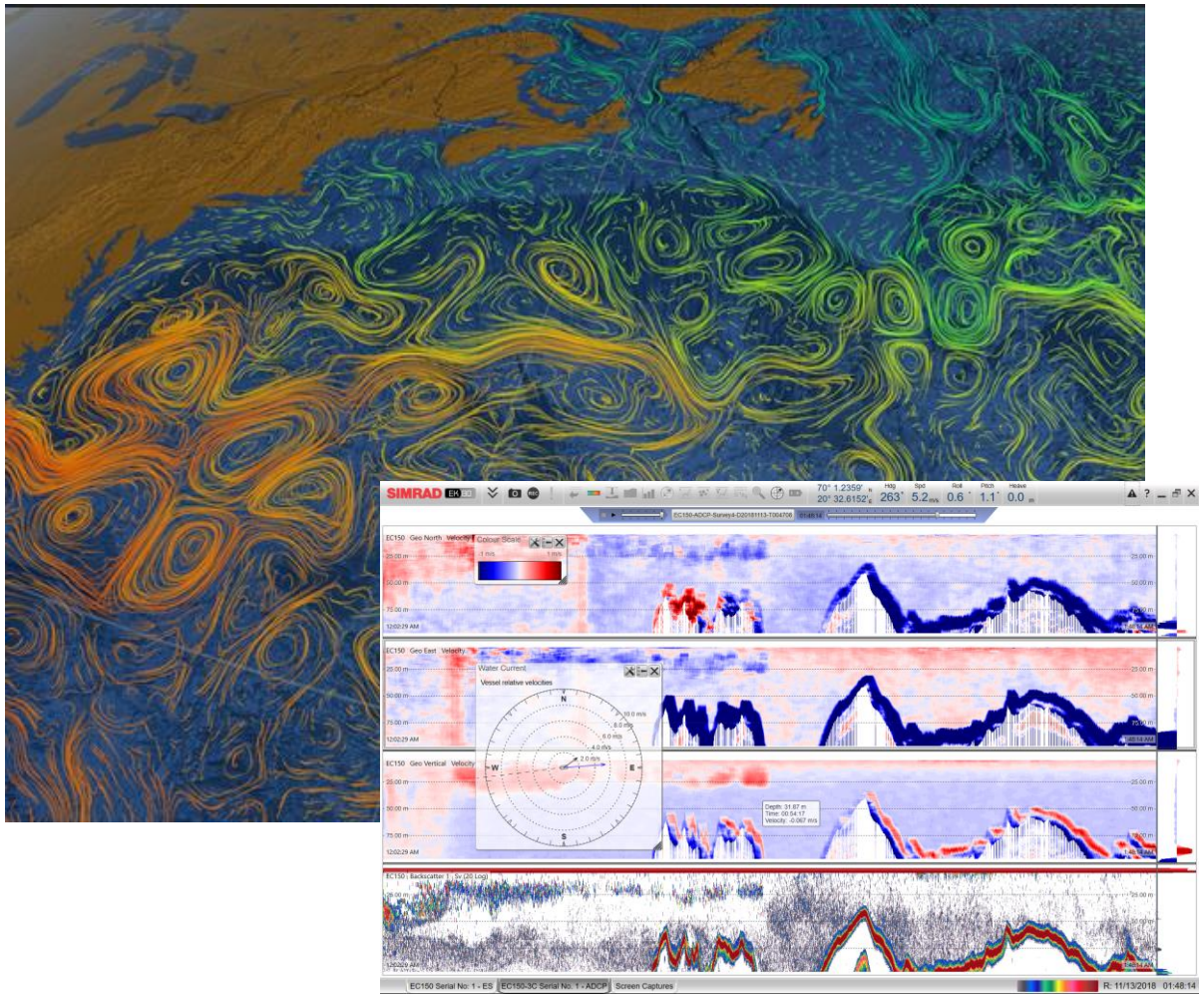
R&A ROV & Survey Platform

- R&A controlled
- Dedicated, un-crewed, self-propelled
- ~24 m length, 135 t displacement (indicative only)
- Diesel-electric battery hybrid propulsion
- 1 x WROV, remote operated LARS
- Hull mounted survey spread by KM, EM 2040-04, TOPAS 120, HiPAP502, Seapath 380, iPS4



EK80 ADCP Background – What and why

- EK80 combines current measurements with calibrated echosounder backscatter in a combined ADCP / split beam echosounder system.
- High resolution ADCP transducer capable of operating in the broad range frequency spectrum.
- Provide current profiles at high vertical resolution with great range performance
- High ping to ping accuracy
- High performance in heavy seas
- Completing Kongsberg's acoustic instrumentation range, making integration and synchronization easier for increased operational efficiency with use of EK80 Software.

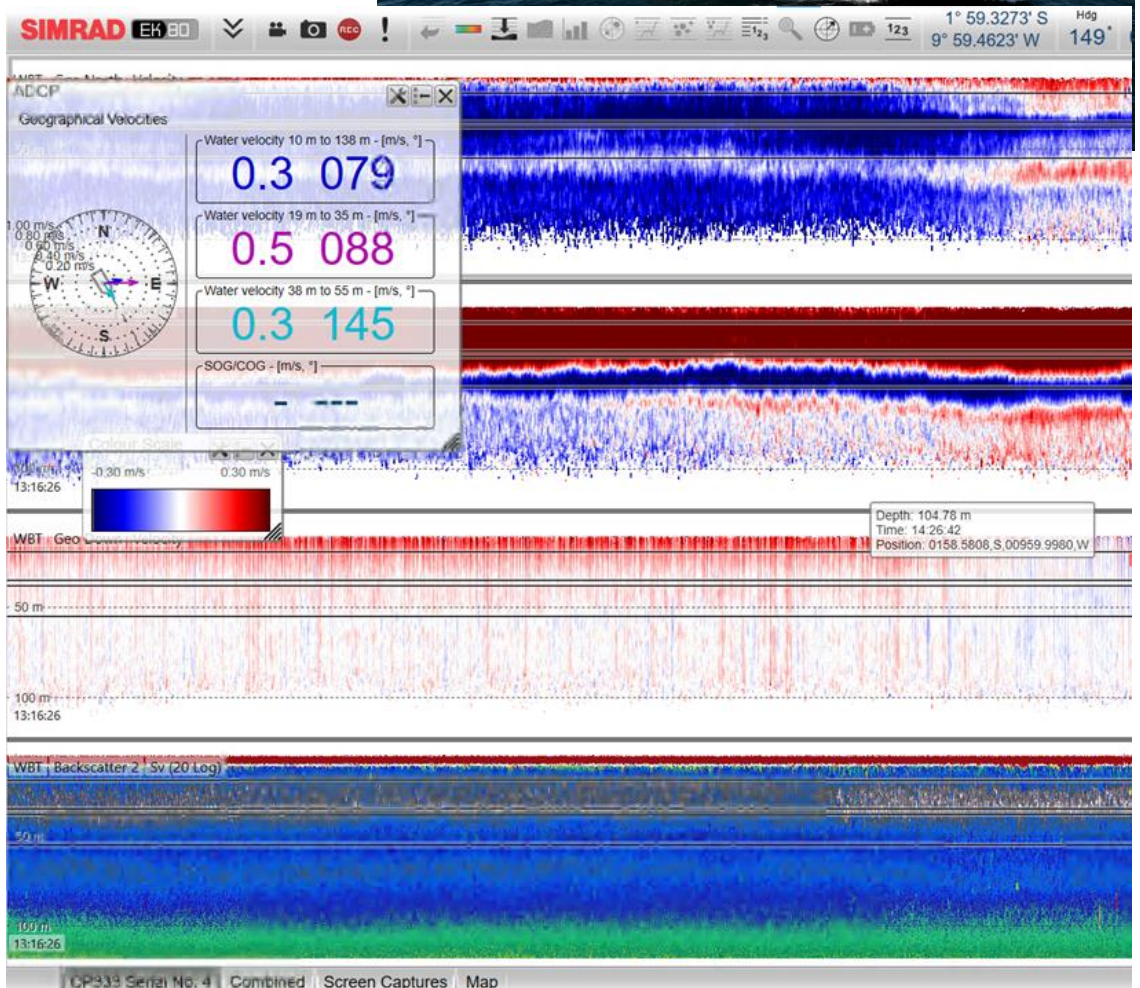


IFREMER / Thalassa CP300 test trials

First results are promising

- Quite amazing fine scale resolution! Mainly explained by
  - Accurate time synchronization system
  - Proper compensation of platform dynamics
- Up-to-date acquisition software (EK80)
- Open-source data format output (netCDF4-SONAR)

IFREMER ordered the CP300 for their new build coastal research vessels within weeks after returning from the test survey, due for delivery later this year



- Preliminary results from PIRATA-FR34 cruise records
- Data and image credits: SNO PIRATA" et "UAR IMAGO" /IFREMER/IRD

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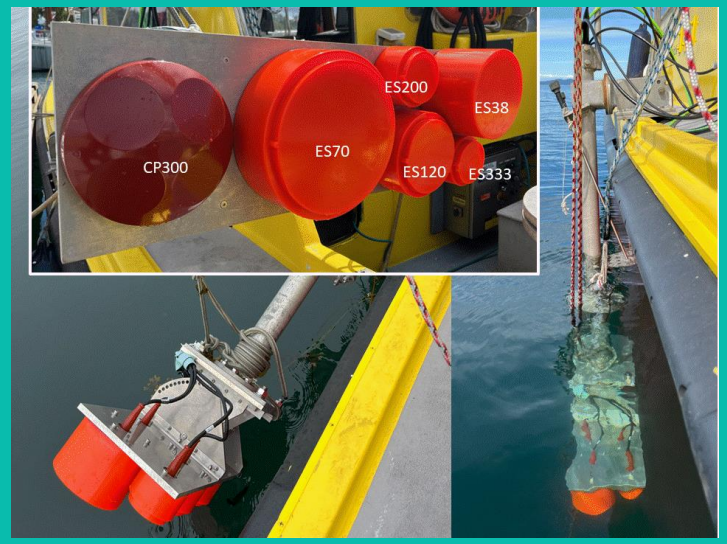
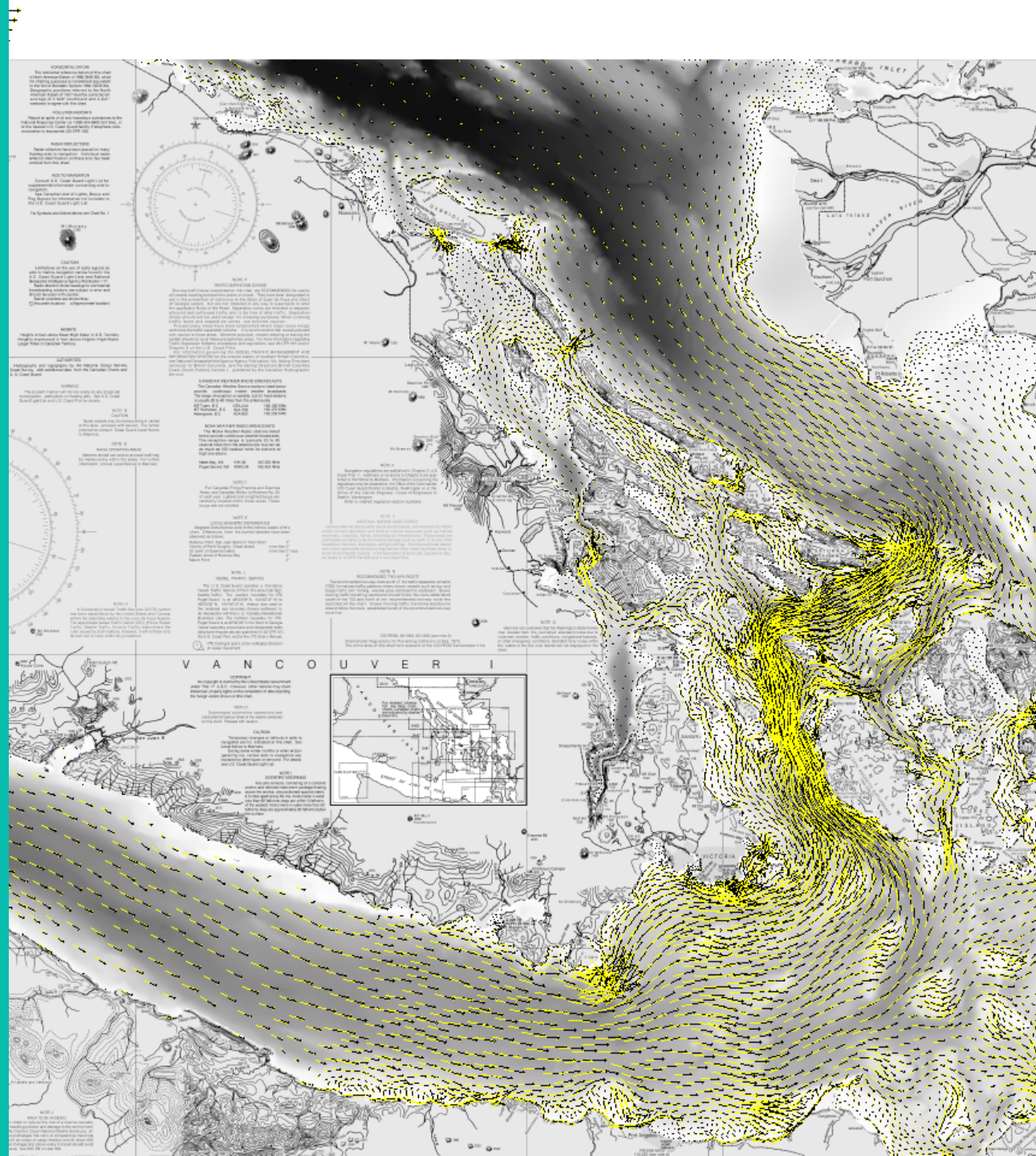
CSL Heron 2024 field programs, Institute of Ocean Sciences, Victoria, BC
Strait of Juan de Fuca, Strait of Georgia
John Hughes-Clarke

Focus areas

- Inter-operability testing, find efficiencies for the 4 new NOAA multipurpose ships (with EM/EK's)
- Comprehension of the new CP300 ADCP
- Assessment of the new 2042 Multibeam
- Calibrated Seabed backscatter from EK80
- Annual update of the areas morhphology.





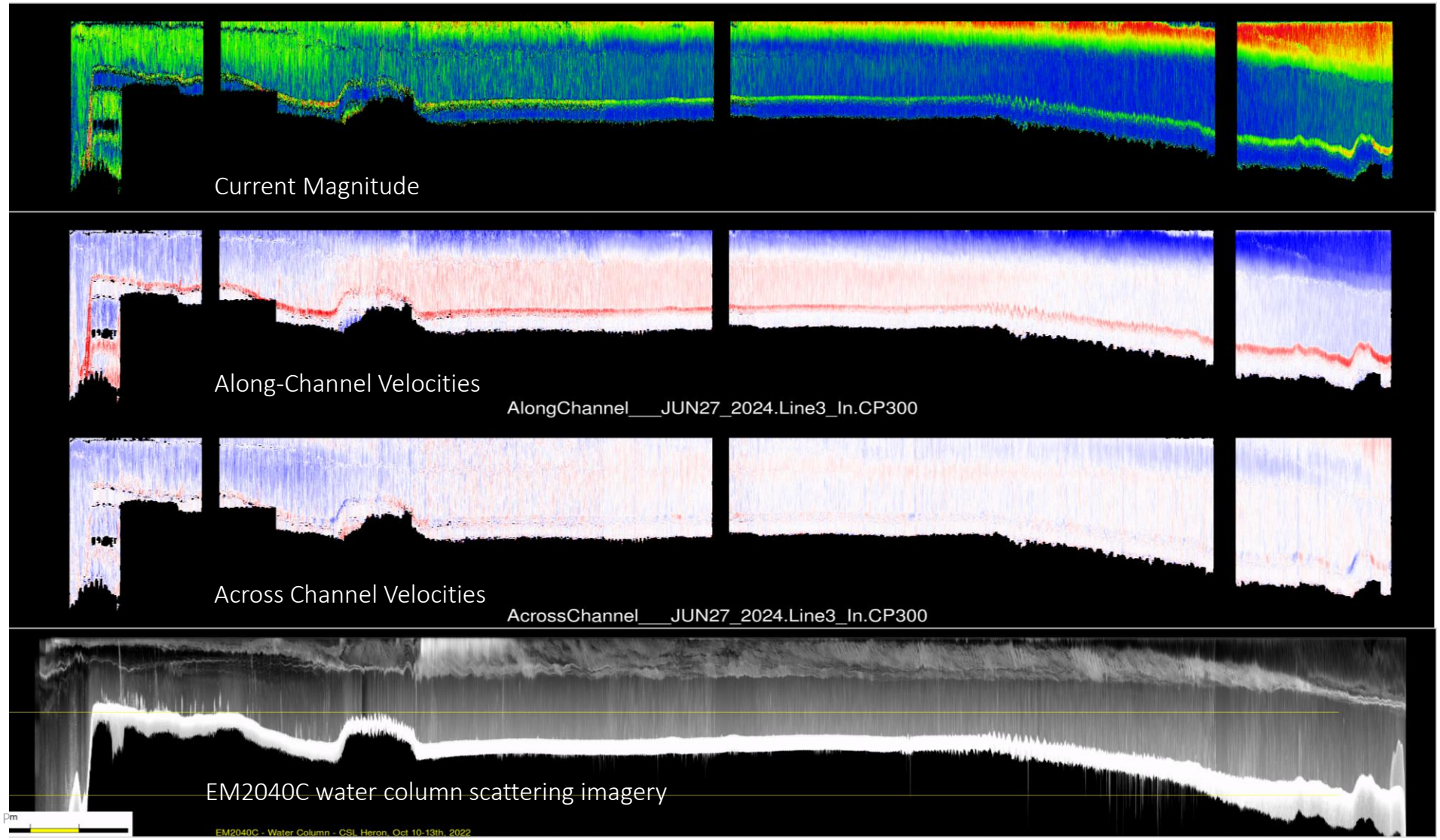
KONGSBERG

CSL Heron 2024 field programs, Institute of Ocean Sciences, Victoria, BC
John Hughes-Clarke
CP300

Preliminary results

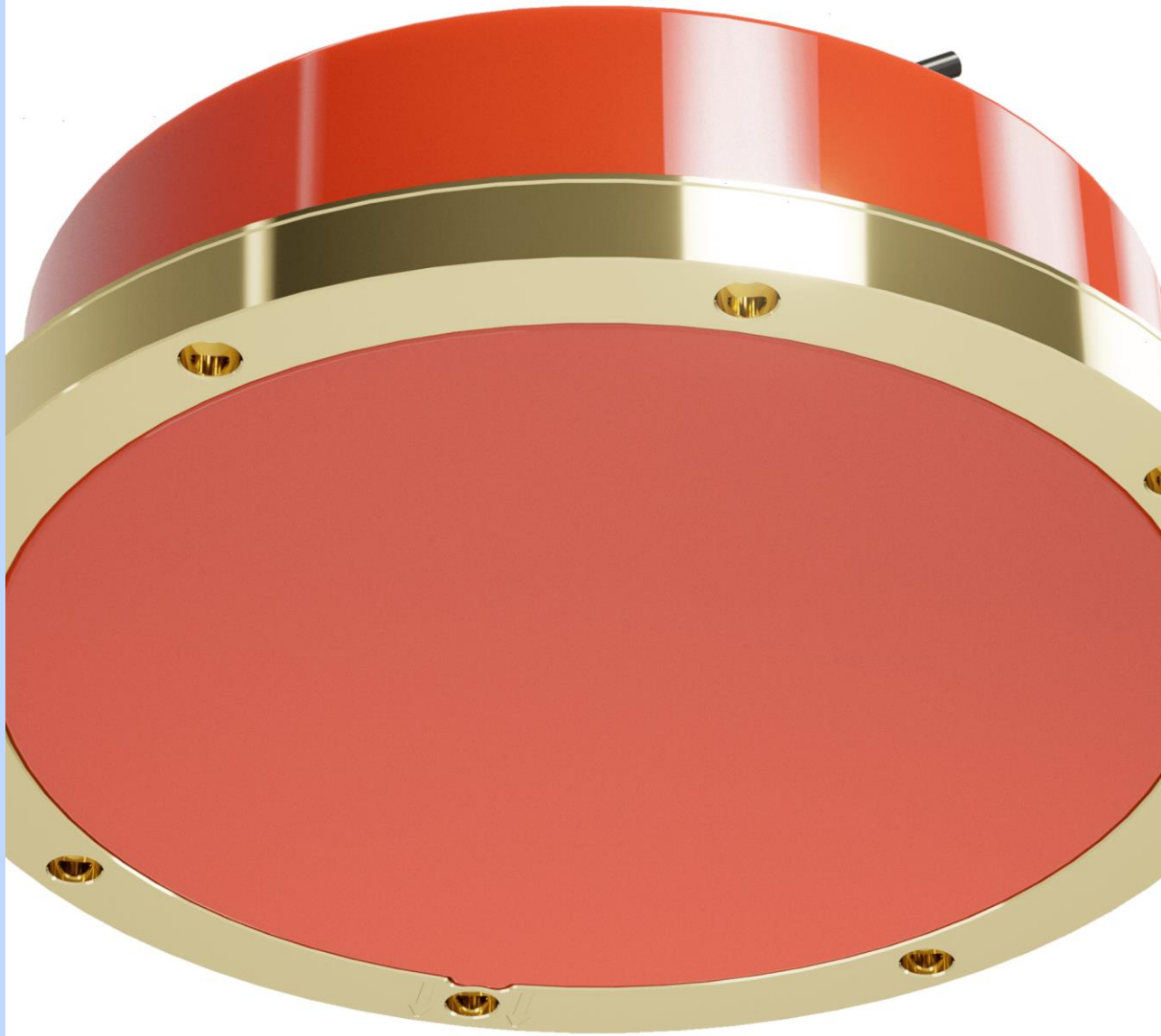
- High ping rate, ideal for MBES combination and dynamic areas
  - 8-9 Hz
- High ping to ping accuracy
  - About 5 pings required to trust velocities
- Next phase will include KM binary input and calibration.

Data/images courtesy John Hughes-Clarke



New EK80 Wideband Transducer: ES18-11 MK2

- Summary:
  - Same size and formfactor as the ES18-11
  - 4 channel Split beam reception
  - Wideband (14 -22 kHz) operation
    - Potentially more with reduced power in the future
  - Max power: 2 kW
  - Indications of less ringing than the previous model

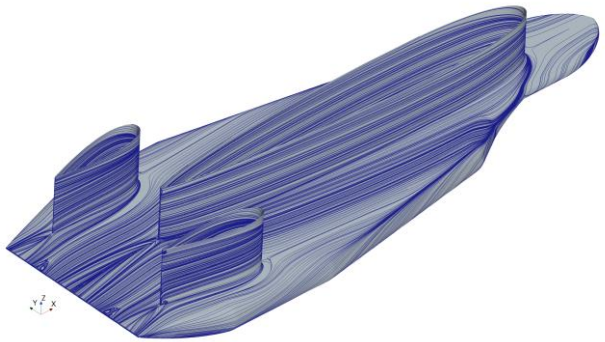


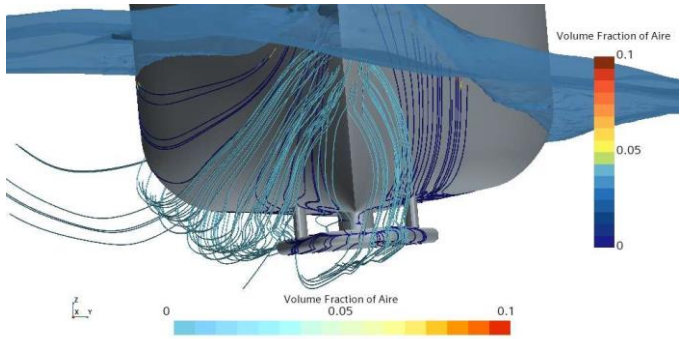
The Designers

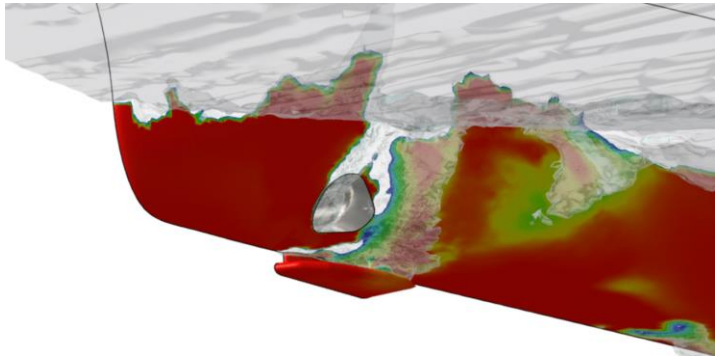
- **Leif Kanschat** (Dipl.-Ing. UAS)
  > 15 years of experience in this field

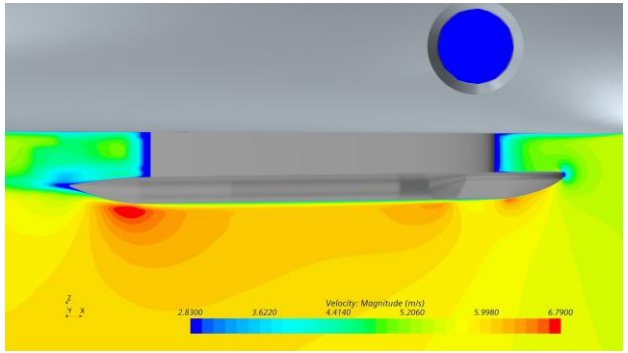
- **Vedran Vickovic** (M.Sc. Marine Engineering)
  > 6 years of experience in this field

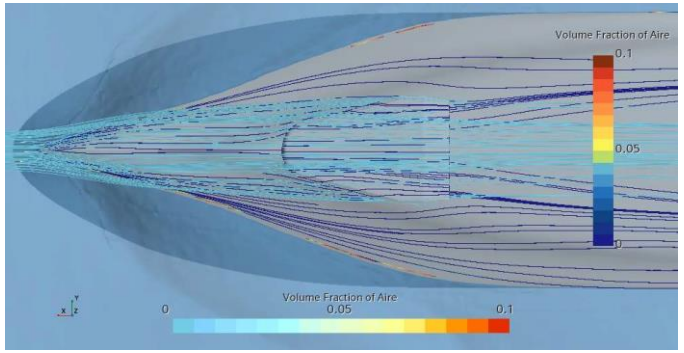
Acoustic performance

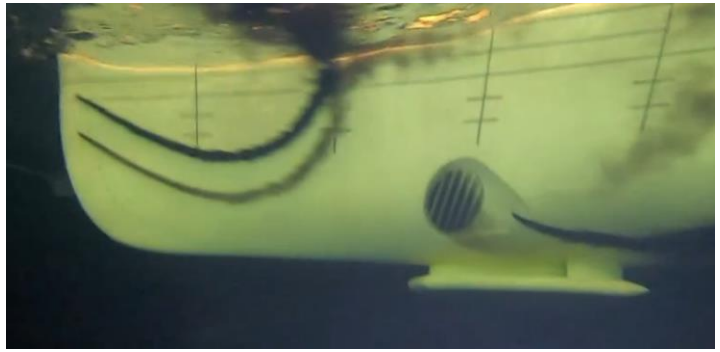












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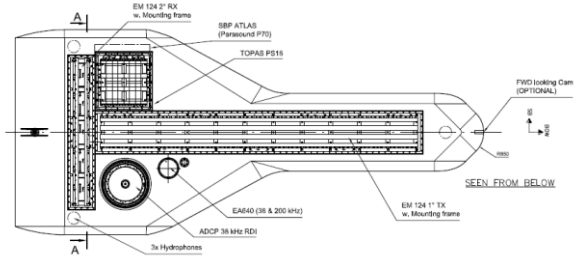
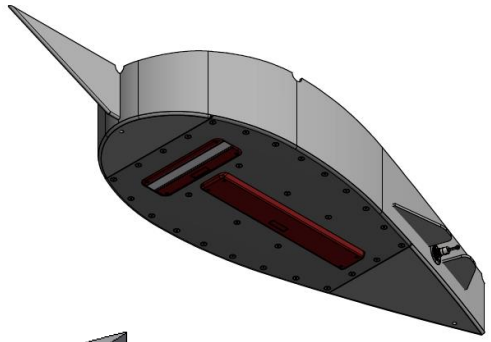
Design Support

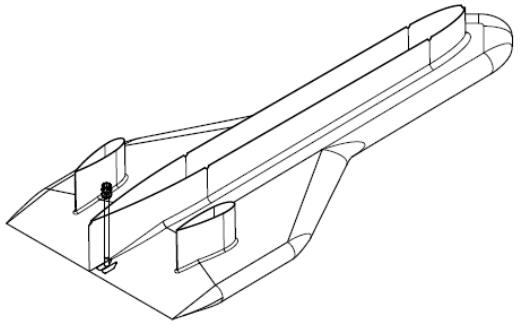
ASIA

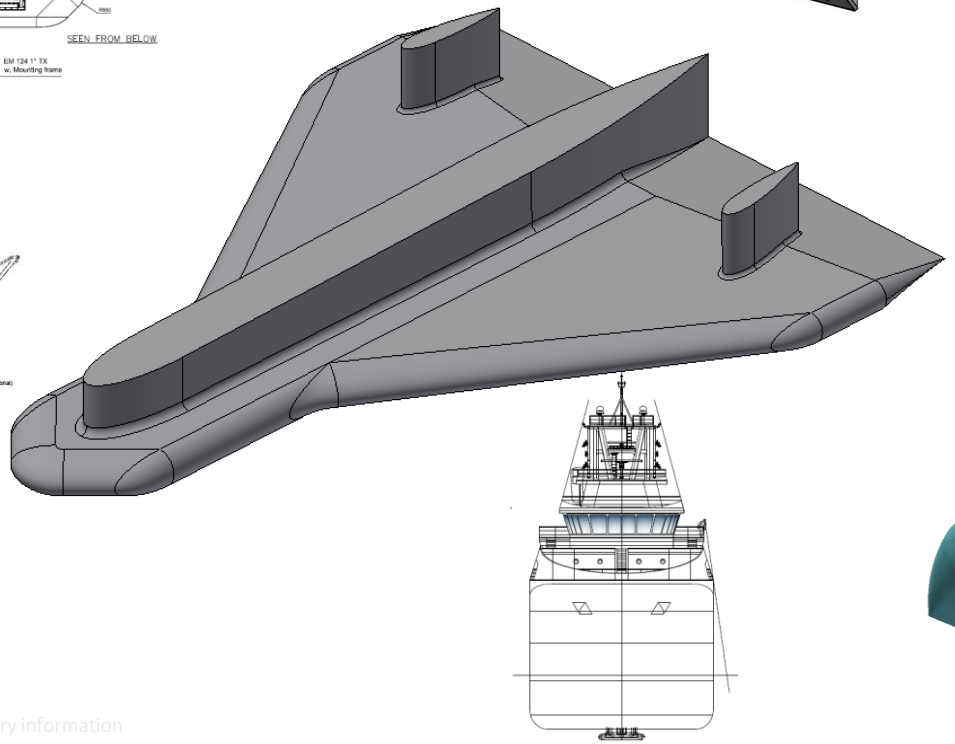
AMERICAS

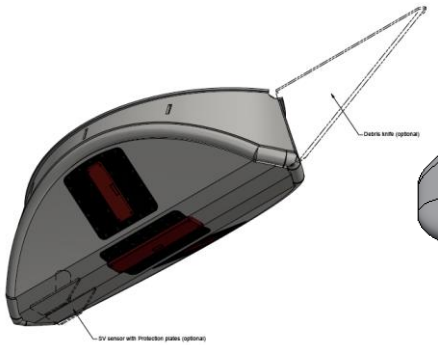
AUSTRALIA

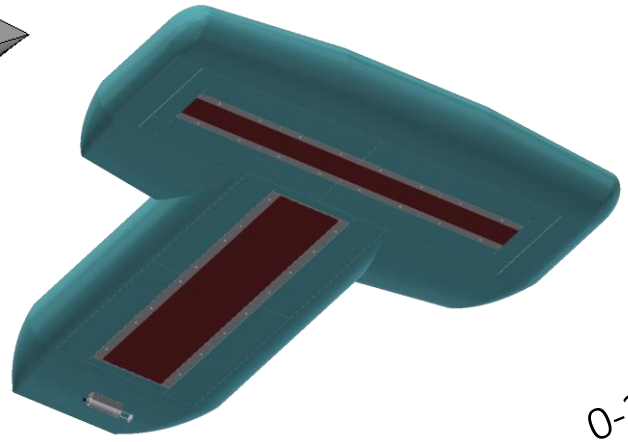












EMEA

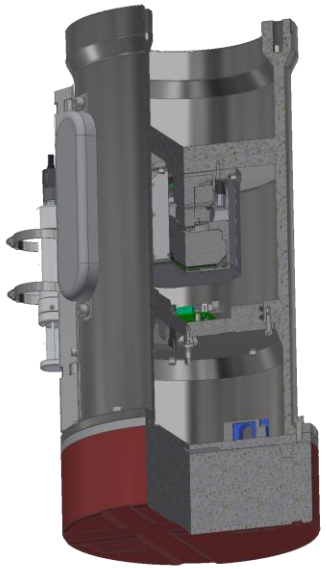
0-24

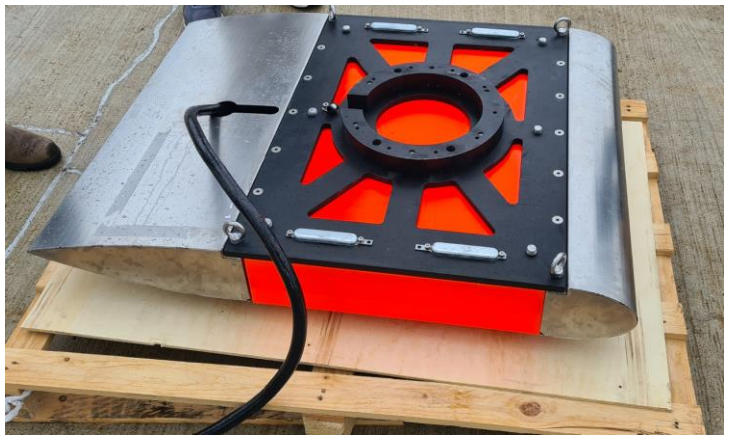
See Statement of Proprietary information

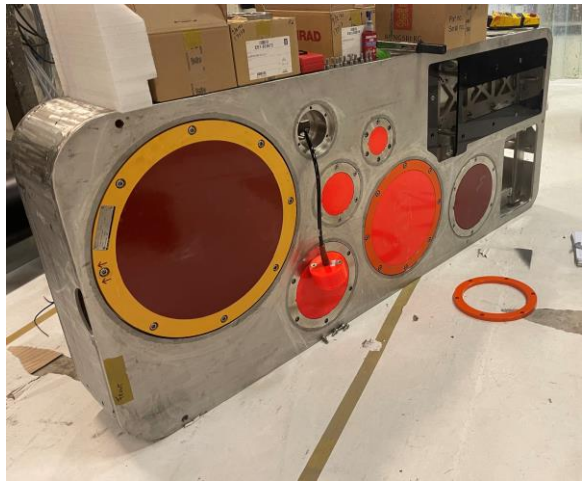
Project support

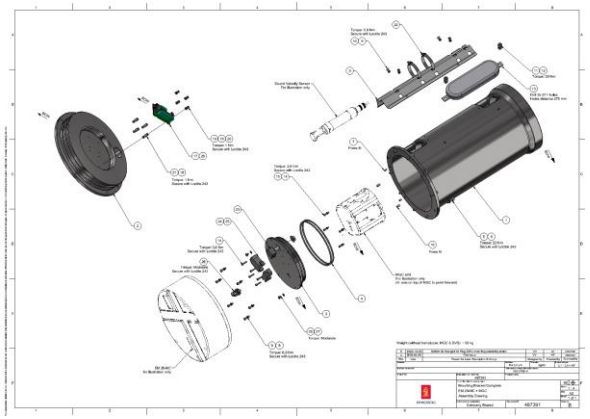
See Statement of Proprietary information

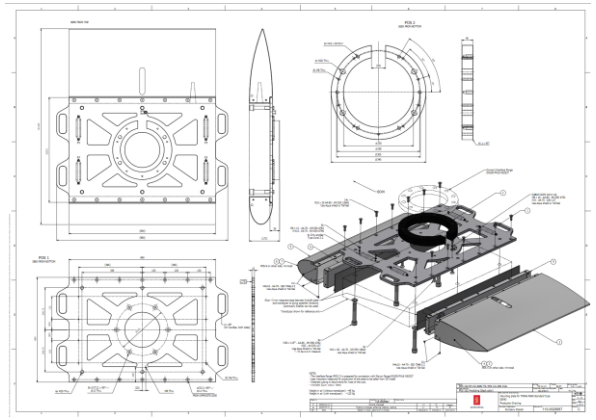
Project support

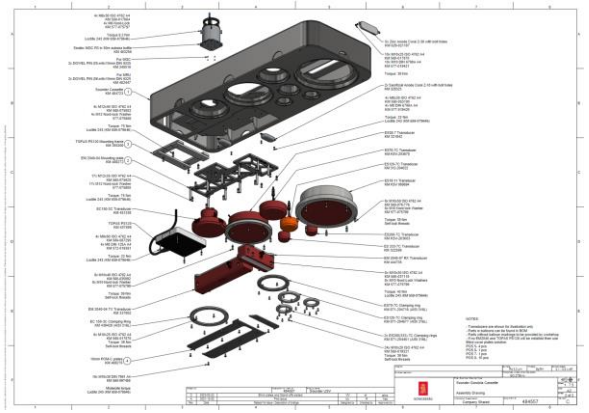












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Training

- Local staff
- Standard offerings
- Customizable – we work with requesting organizations to make appropriate, valuable offering
- Kongsberg location or customer location
- Increasing demand
- Classroom with hands on components

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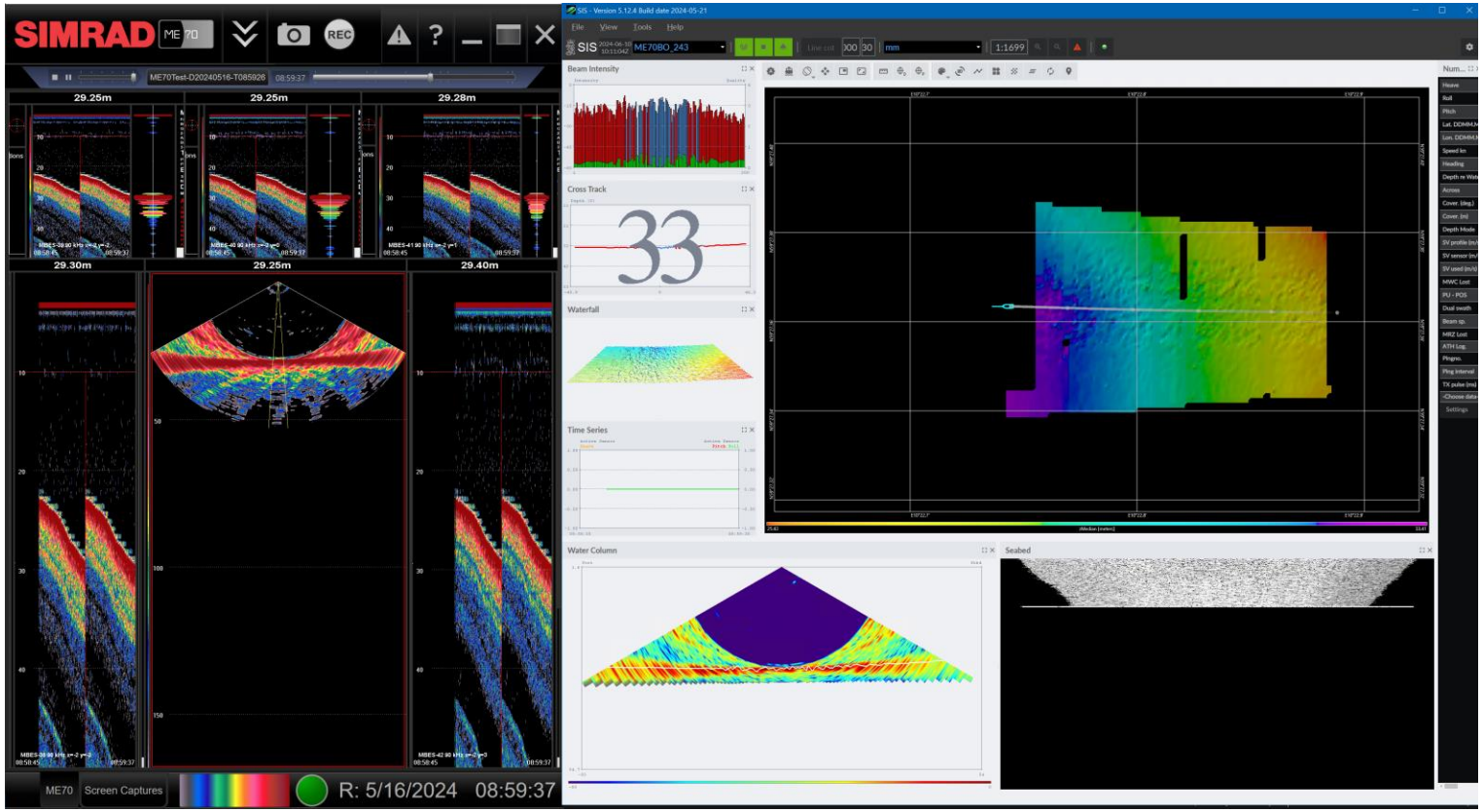
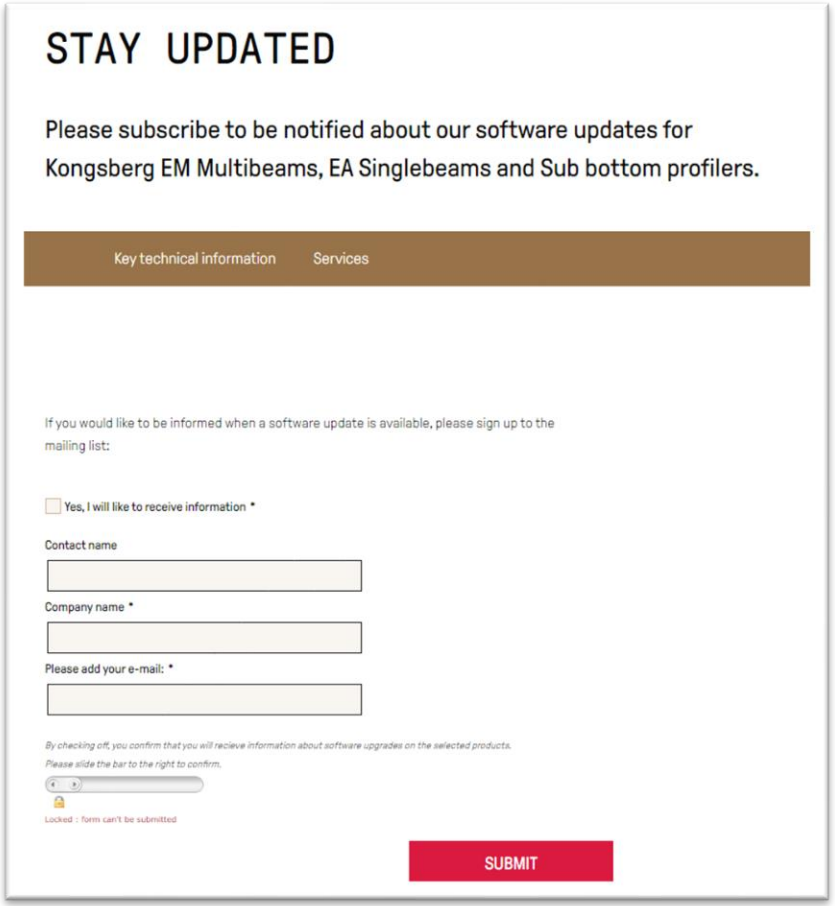
R&D

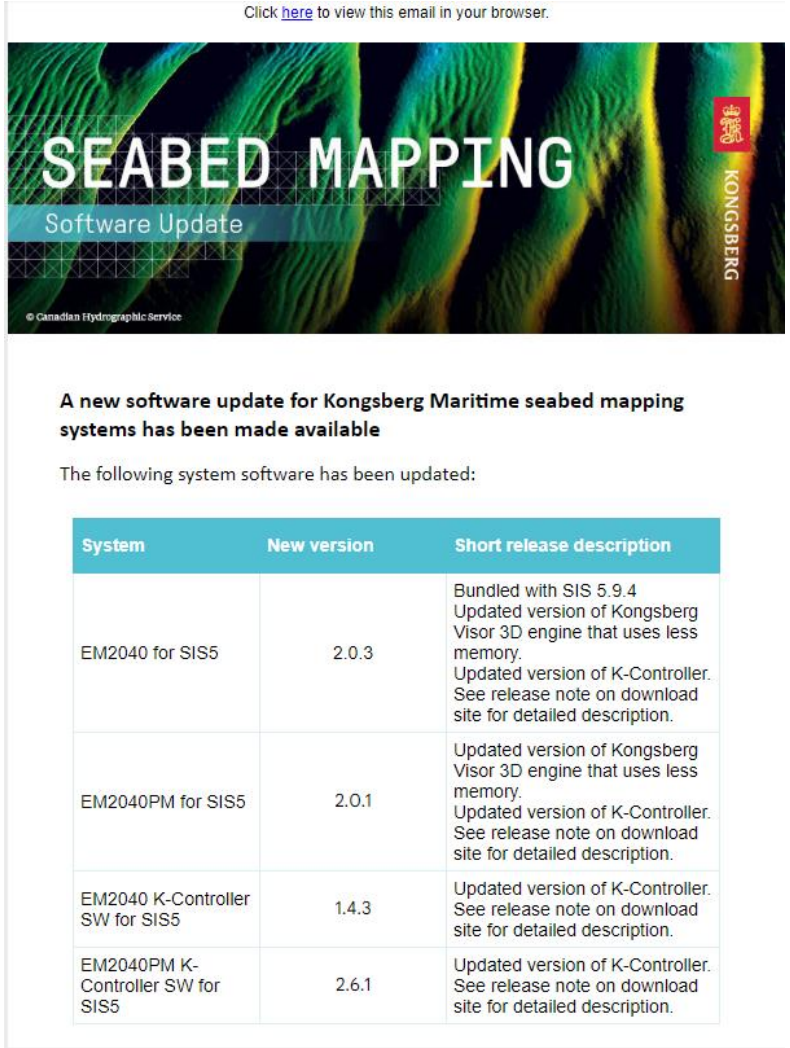
- Early phases of Skathi – next generation shallow water multibeam – 300 – 700 kHz
- Early phases of Skuld – next general deep water multibeam
- ME70 operation within SIS environment



Sign up for mapping news updates - Kongsberg Discovery

Sign up for Mapping News Updates





Thank you!

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