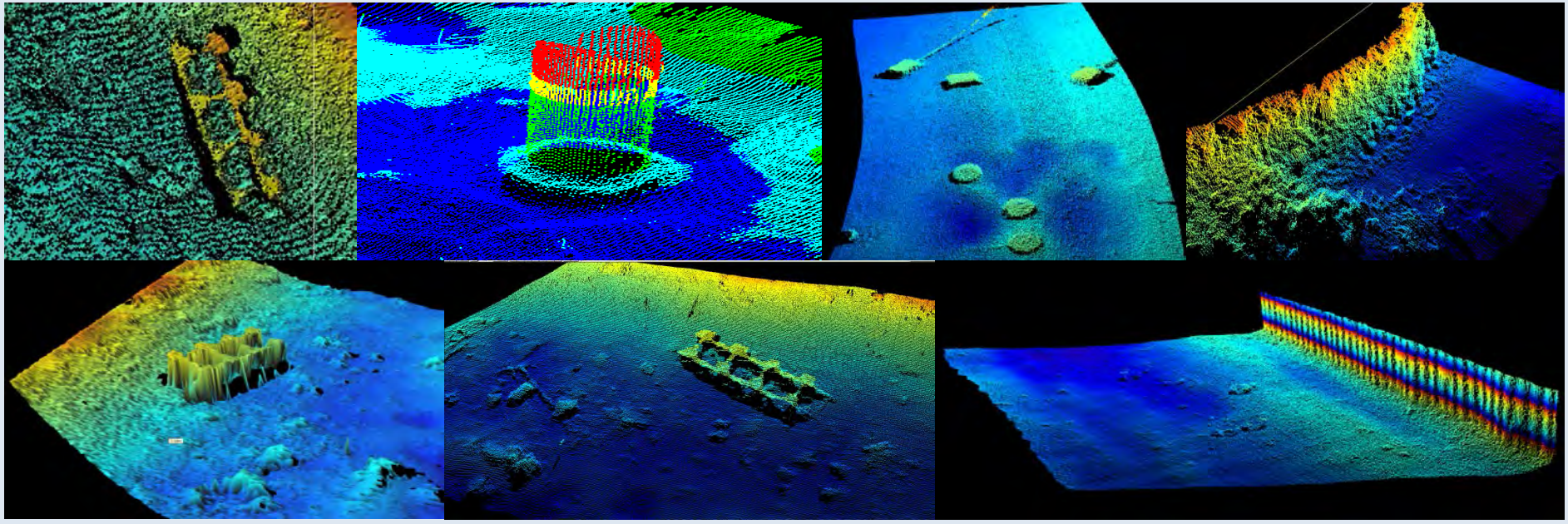
Revolution in Resolution

EM 2040 Wideband multibeam

Helge Uhlen
Product Sales Manager
Kongsberg Maritime



EM 2040 - Wideband Multibeam

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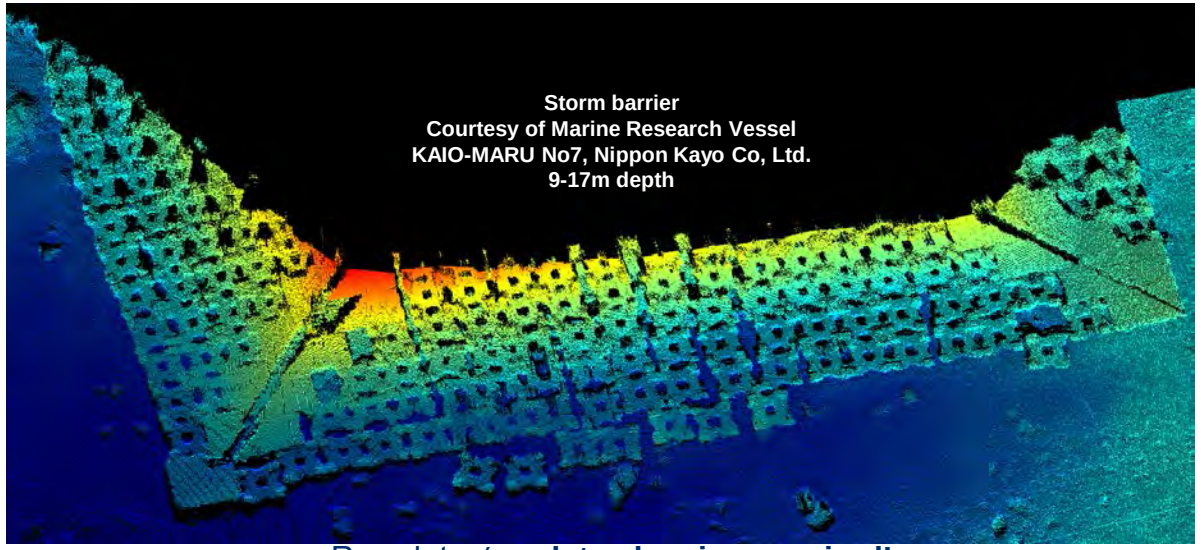
Why go for EM 2040 ?

- EM 2040 has the highest specification
- EM 2040 produces in real-time the cleanest data
- EM 2040 comply fully with S-44 special order and LINZ even in rough weather conditions
- EM 2040 is the first shallow water system to bring all advanced features of the deep water multibeams



Raw data, **'no data cleaning required'**

EM 2040 – Wide Band Multibeam
Survey requirements

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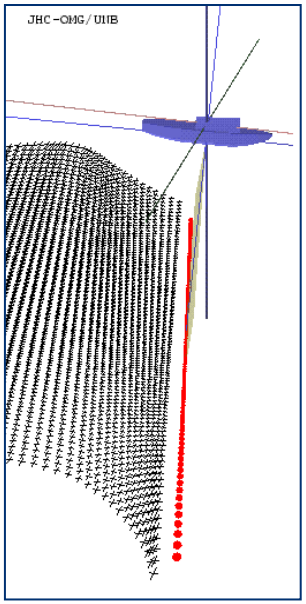
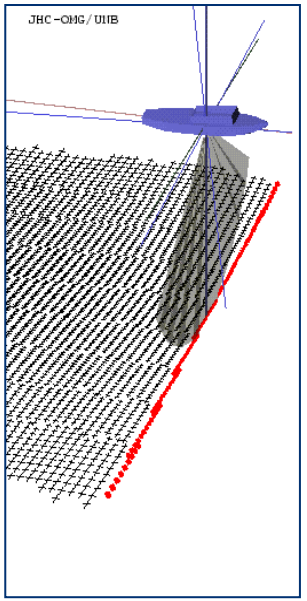
In order to meet IHO S-44 requirements **in all weather conditions**, the following features are necessary:

- Real-time stabilization of TX/RX beam for yaw, pitch and roll movements
- Sector transmission for robust bottom detection
- Nearfield focusing on both transmit and receive
- Dual swath per ping to meet Special order at 8 knot (or increased survey speed)



No stabilization



Roll, Pitch and Yaw stabilization

EM 2040 – Wide Band Multibeam
Survey requirements

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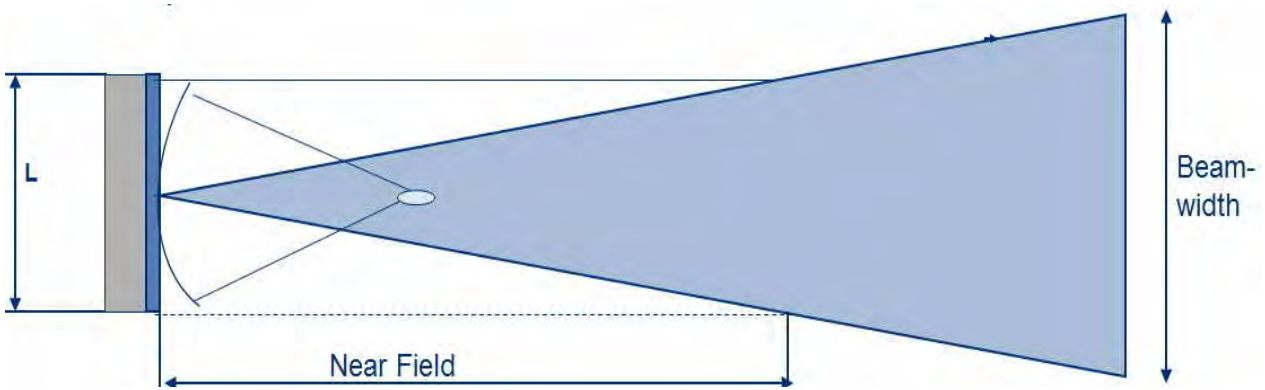

Inside the near field the beam-width is as wide as the physical size of the transducer

When is focusing necessary ?

The near field length of a system depends on frequency and TD length:

Examples:
EM 2040-04: ~100m
EM 2040-07: ~25m

EM 2040 – Wide Band Multibeam
Survey requirements

In order to meet IHO S-44 requirements **in all weather conditions**, the following features are necessary:

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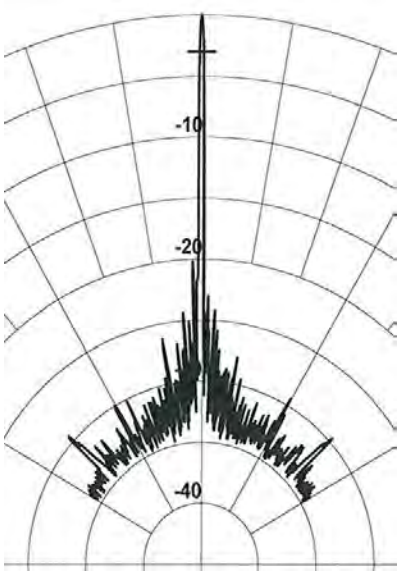
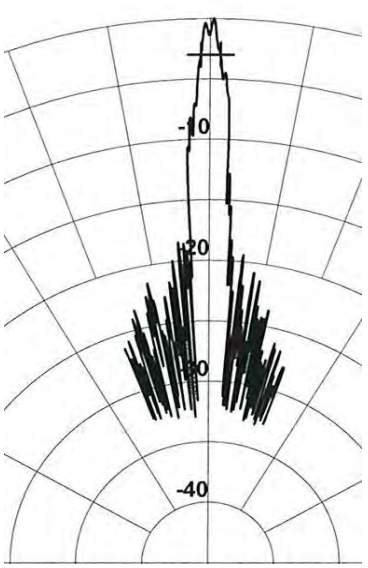


Focusing enabled.
Beamwidth is **0.4 deg**.



Focusing disabled,
Beamwidth is 5 deg.
SL is 6 dB weaker

When is focusing necessary ?

The near field length of a system depends on frequency and TD length:

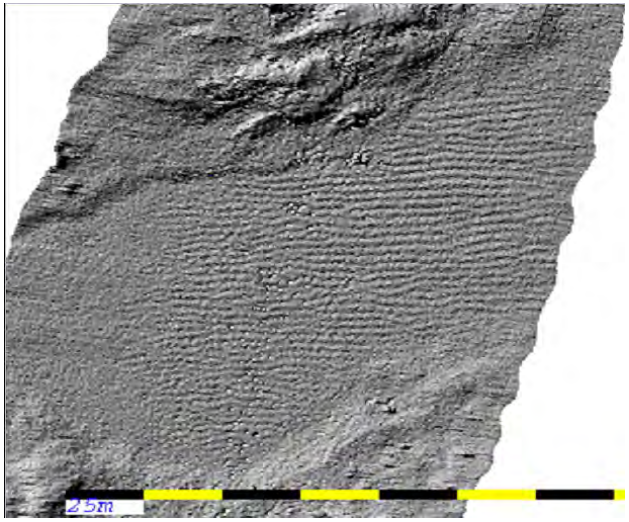
Examples:
EM 2040-04: ~100m
EM 2040-07: ~25m

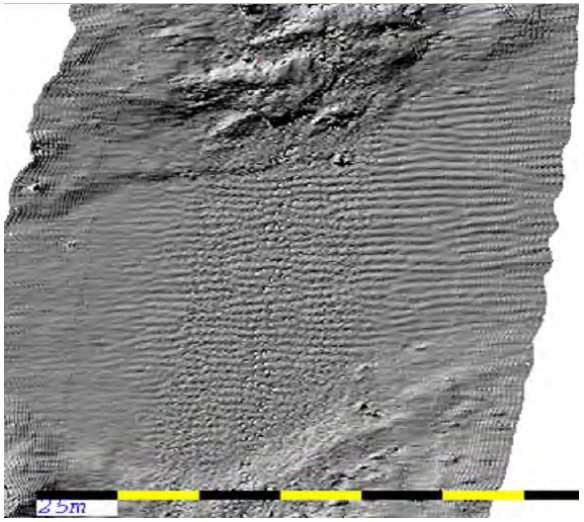
EM 2040 – Wide Band Multibeam
Survey requirements

In order to meet IHO S-44 requirements **in all weather conditions**, the following features are necessary:

- Maintaining of all beams when swath coverage is reduced (auto/manual)
- High density beam processing for reduced footprint size
- FM chirp for long range and high resolution even in noisy environment

400 soundings vs 256 beams





The result of this technique:
-Higher resolution in outer beams
-Higher across track density

The footprint size is reduced to <30% in the outer beams

EM 2040 – Wide Band Multibeam
System overview

Operator workstation
- Standard high end computer

Processing Unit
-19” rack mount
- 4U high
- Rack and AUV versions available

Transmit and receive transducers
- Single RX (one TX and one RX transducer)
- Dual RX (one TX and two RX transducer)

EM 2040 – Wide Band Multibeam
System overview

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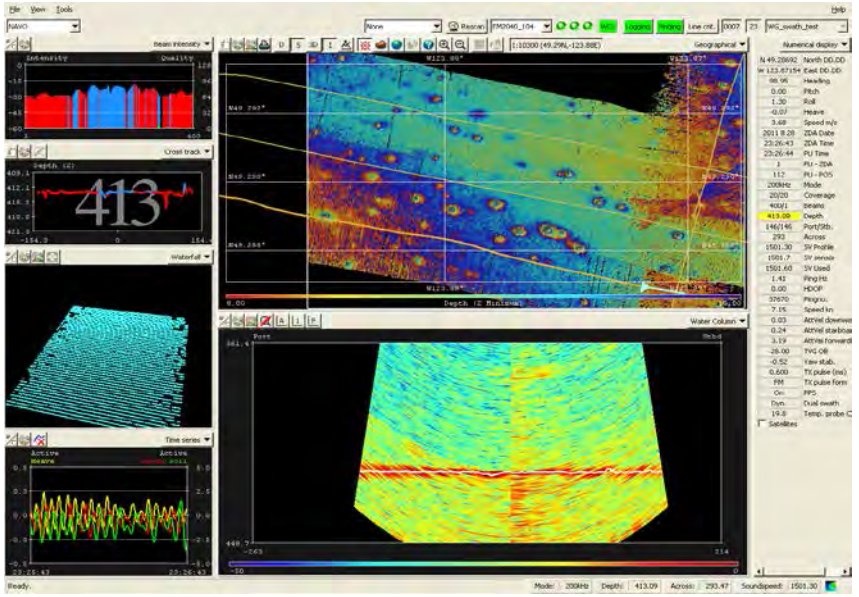
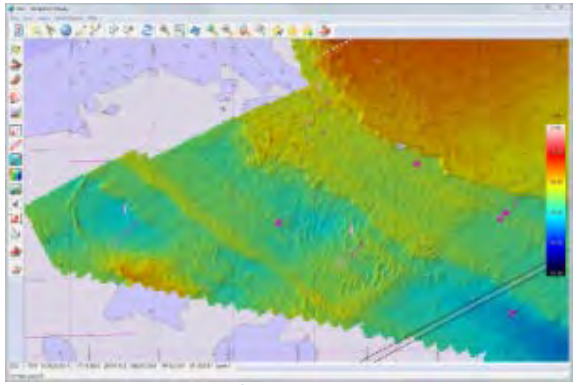
Operator software

EM 2040 can be delivered with the following operator software:

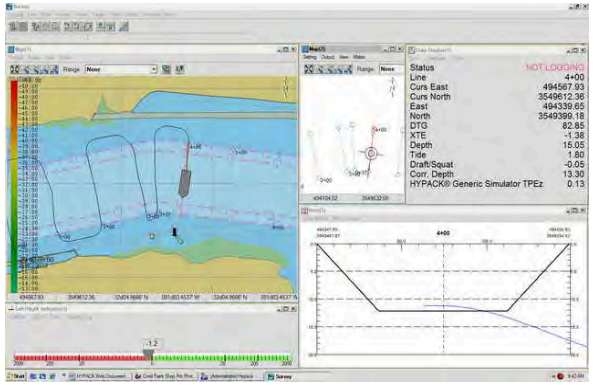
- *SIS from KM*
- *QINSy from QPS*
- *HYPACK*
- *EIVA*
- *Triton*



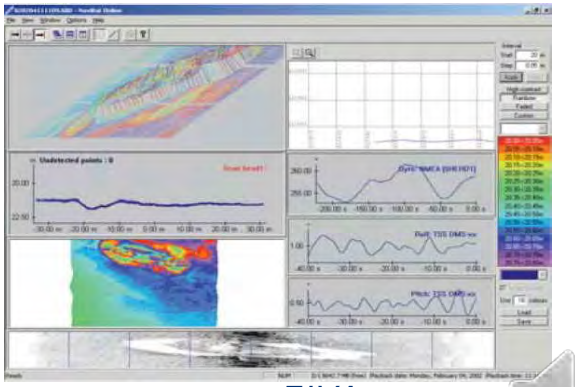
SIS from KM



QINSy from QPS



HYPACK



EIVA

EM 2040 – Wide Band Multibeam
System overview

EM 2040 0.7 degree RX transducer
Dimensions : 41 x 14 x 14 cm (L x W x H)
Weight : 16 kg

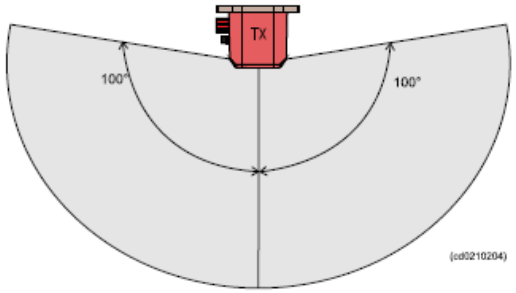
EM 2040 0.7 degree TX transducer
Dimensions : 41 x 14 x 15 cm (L x W x H)
Weight : 16 kg

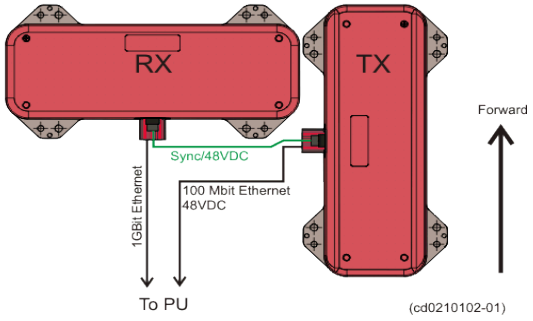
EM 2040 0.4 degree TX transducer
Dimensions : 73 x 14 x 15 cm (L x W x H)
Weight : 30 kg

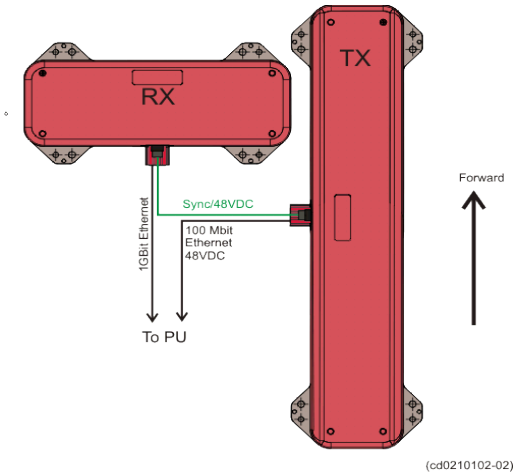
EM 2040 – Wide Band Multibeam
System overview

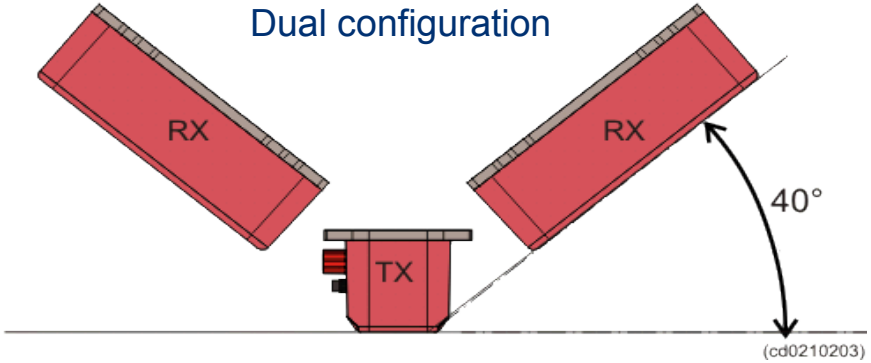
Available system configurations:

EM 2040-07: 0.7 x 0.7 degree (TX x RX)
EM 2040-04: 0.4 x 0.7 degree (TX x RX)
Both available in Dual RX for increased coverage









Single RX -07:
Coverage 5.5x Depth
(140 degrees)

Single RX -04 :
Coverage 5.5x Depth
(140 degrees)

Dual RX -04/-07:
Coverage 10x Depth
(200 degrees)

EM 2040 – Wide Band Multibeam
System specification

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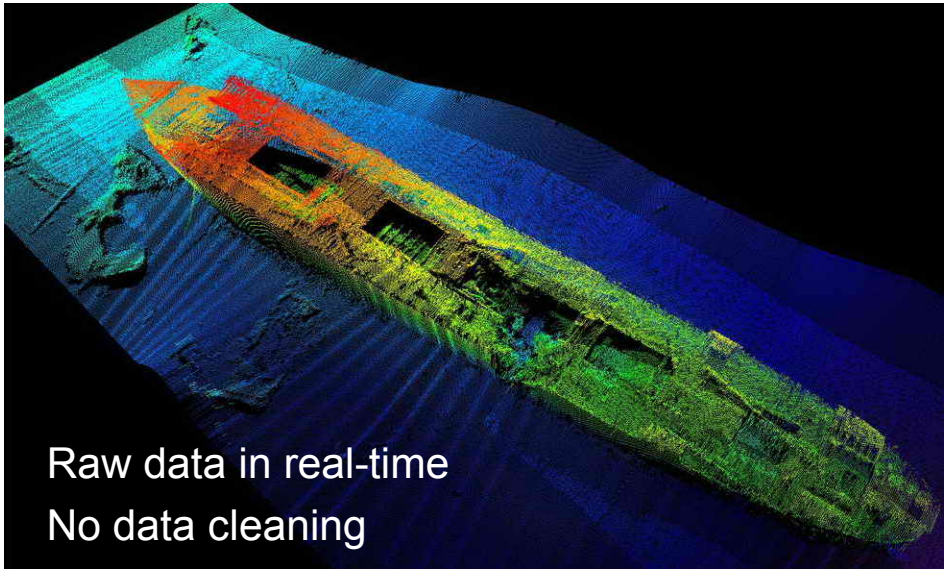
Frequency : 200 - 400 kHz

Range : 0.5m down to 600m

Swath per ping : Single and Dual swath

Stabilization : Active roll, pitch and yaw
(+- 15/10/10 deg)

Compensation : Roll, pitch, heave



Beam angles :

	200 kHz	300 kHz	400 kHz
0.4° TX	0.7°	0.5°	0.4°
0.7° TX/RX	1.5°	1.0°	0.7°

EM 2040 – Wide Band Multibeam
System specification

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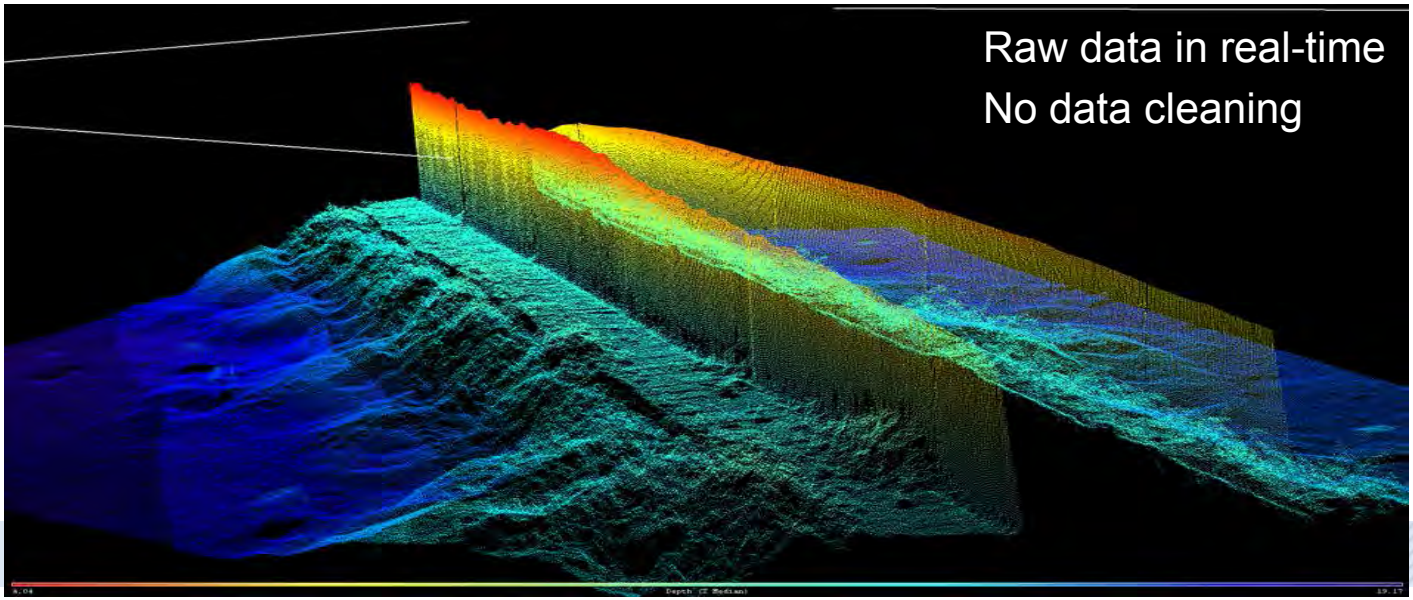
No of soundings : Single RX - 400 / 800(Dual Swath)
Dual RX - 800/ 1600(Dual Swath)

Swath width control: Maintain all beams when swath width is reduced due to max range or manual

Pingrate : >50 Hz

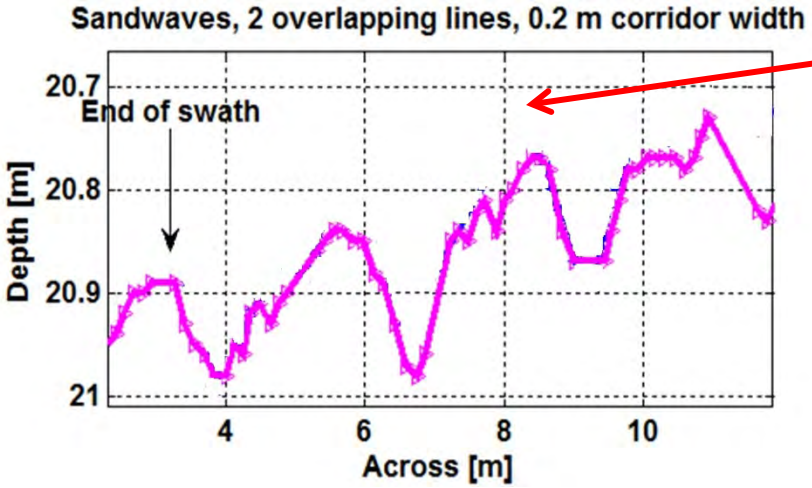


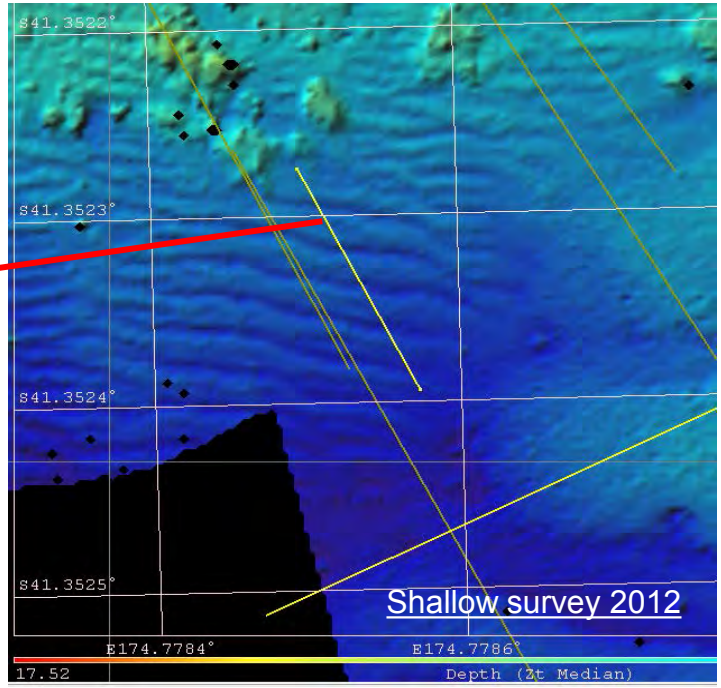
EM 2040 – Wide Band Multibeam
System specification

Beam processing : High density beam processing

The footprint size is reduced to less than 30% in the outer beams

Focusing : On transmit and receive





High density mode

Sand-waves are tracked through out the swath. 1cm ripples can be seen.

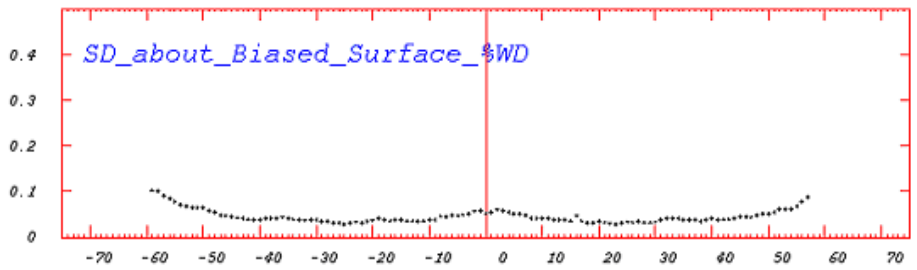
EM 2040 – Wide Band Multibeam
System specification

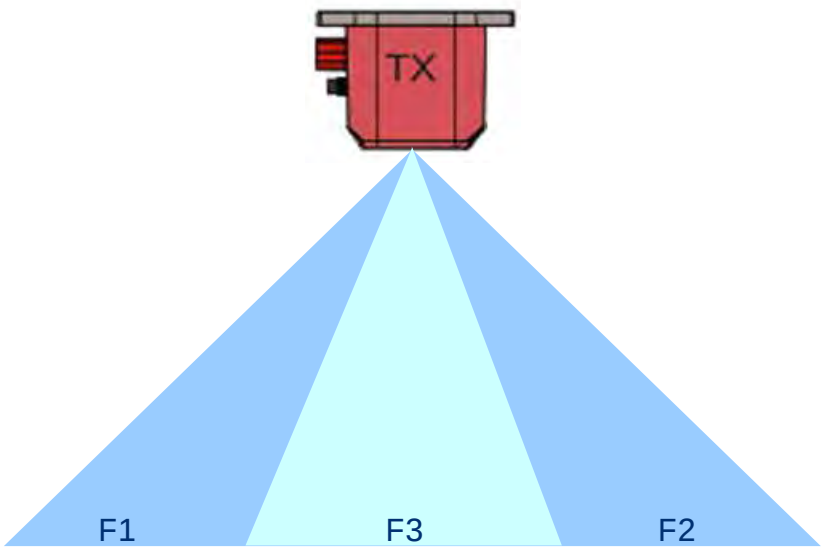
TX pulse : CW and FM Chirp

TX pulses : From 25us (CW) to 12ms (FM)

TX beam forming : 3 transmit sectors

Accuracy (cт/4) : <10mm





Standard deviation
0.1% of depth (67%) when combined with high-end sensors.

Benefit of sector transmission:
- Very effective yaw and pitch stabilization
- Strong damping of interference
- Individual TX focus in each sector gives a smaller TX footprint

EM 2040 – Wide Band Multibeam
System specification

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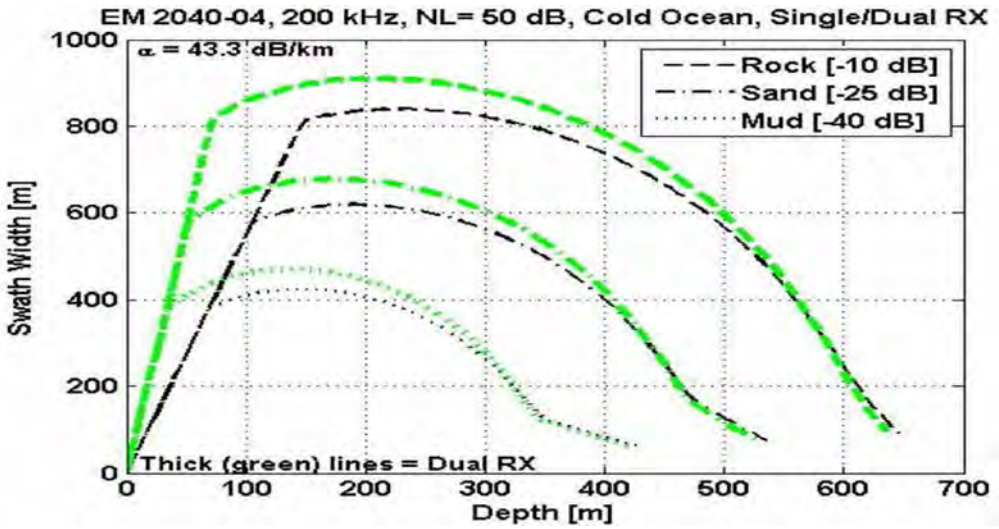
Coverage Single RX:140 deg / 5.5x water depth

Coverage Dual RX : 200 deg / 10x water depth

Coverage TX : 200 deg

Coverage plot for 0.4x07
Single RX vs Dual RX



EM 2040 – Wide Band Multibeam
System specification

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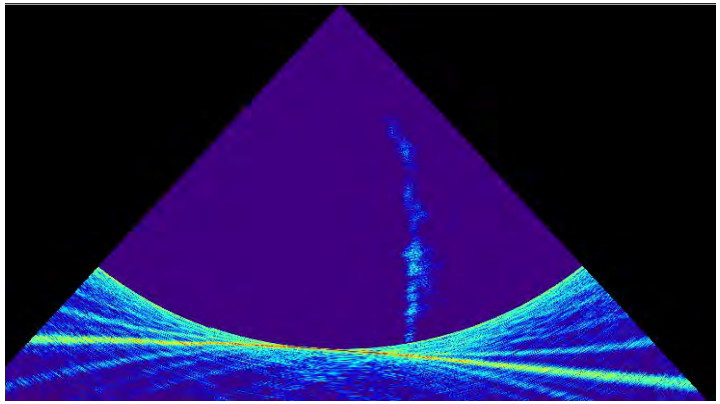
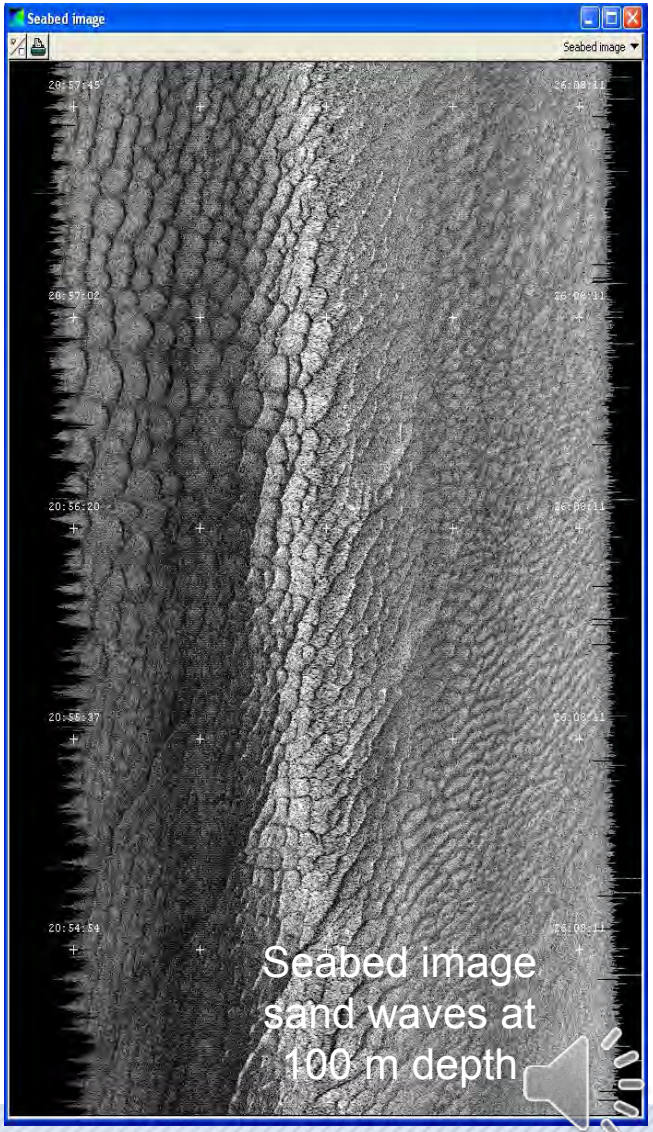
Time synchronization: Ethernet IEEE 1588 and ZDA / 1PPS

Water column : Display and logging of water column data (logging as option)

Seabed Imagery : High quality beam-formed, included as standard

Gas leak detection





EM 2040 – Wide Band Multibeam
Water Column Data

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Water column logging

Water column data can selectively be logged to either the standard log file (.all) or to a separate water column file ('.wcd').

Typical data rate (Mbyte/hour) per swath with EM 2040					
Depth below transducer	Bathymetry	Seabed Image	Water Column	Velocity	Mode
10 m	850	350	5500	43	Very shallow
45 m	225	165	3200	43	Shallow
200m	100	50	1700	43	Deep (FM)

The difficult part of water column processing is to separate the gold nuggets from the rest of the worthless data.

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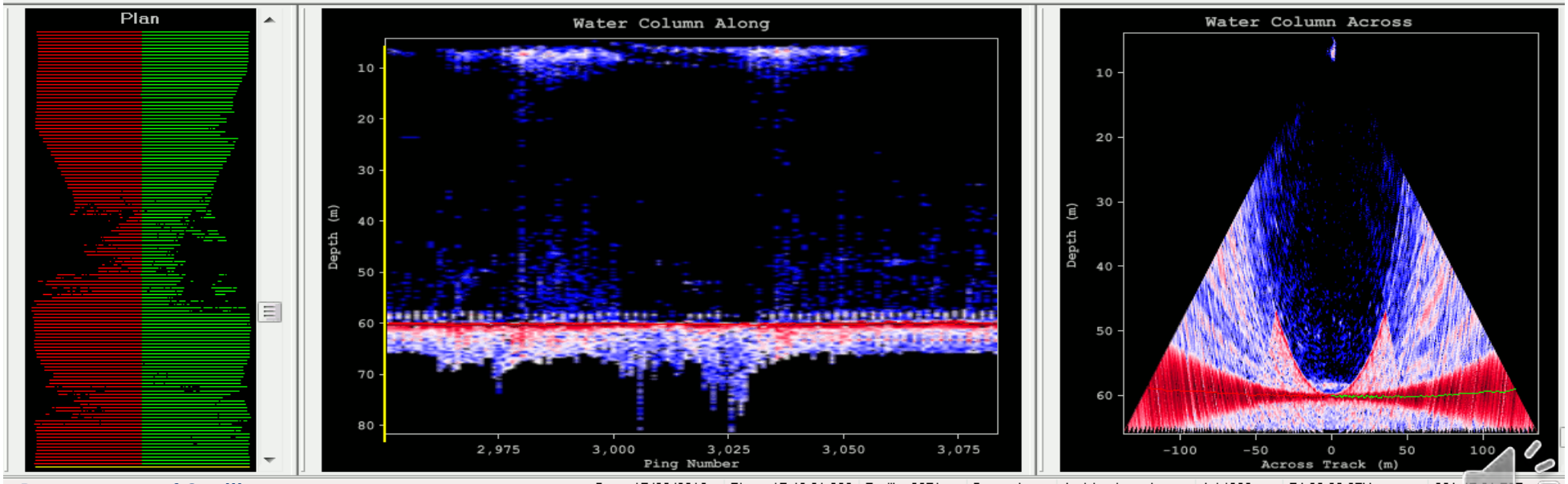
EM 2040 – Wide Band Multibeam
Water Column Data

It's not all about the pretty picture!

EM multibeam echosounders provide amazing water column data as well as bathymetric information even under rough survey conditions.

Water column data has rapidly become a necessary information for many ocean mapping applications. In this example the WCI module in CARIS HIPS is used to investigate acoustic noise caused by aerated water at the transducer array.



Data courtesy of Gardline

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EM 2040 – Wide Band Multibeam
FM chirp

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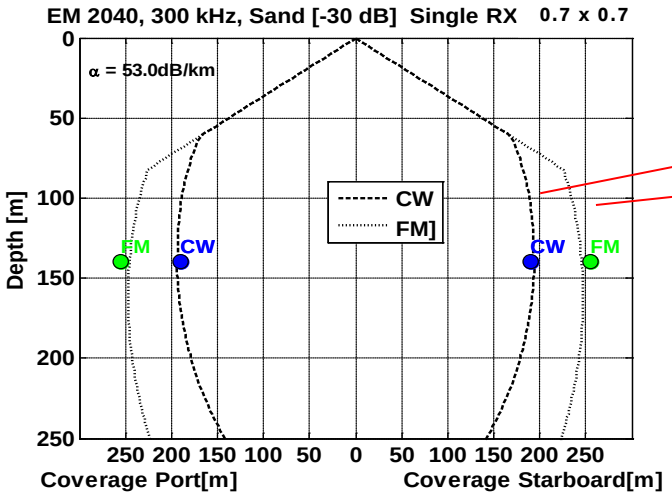
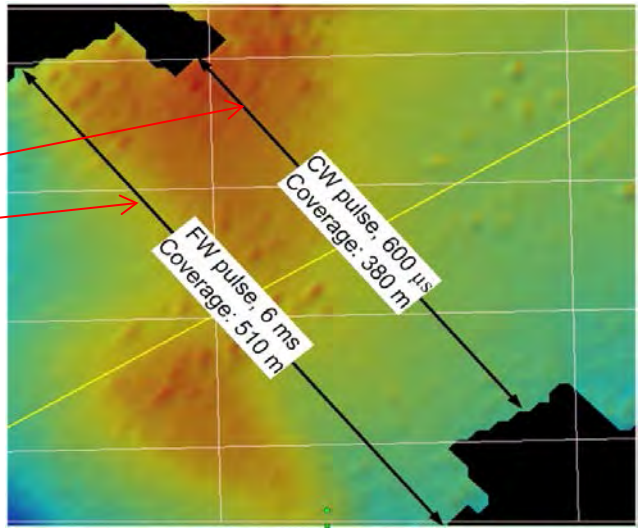
Why use FM ?

The benefit compared to CW is increase in range / swath coverage and increase of resolution



Estimated coverage



Measured coverage

Up to 35% increase in swath coverage has been verified when switching from CW to FM

EM 2040 – Wide Band Multibeam
FM chirp

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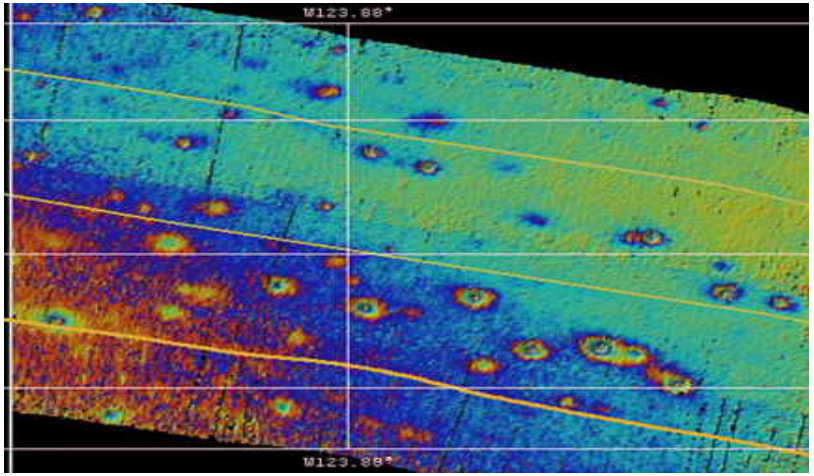

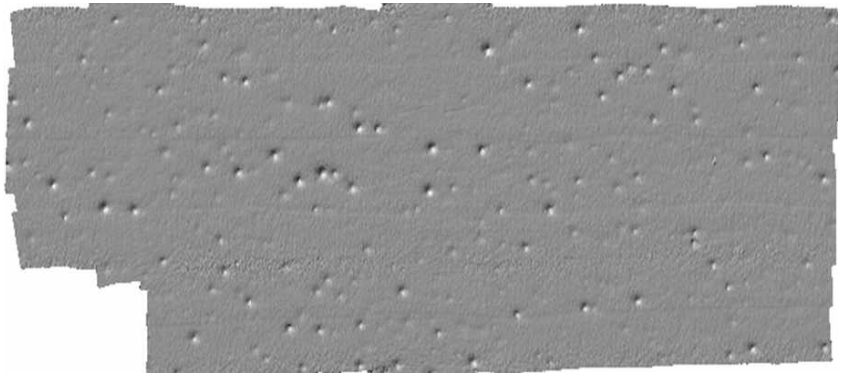

EM 2040-04:
1-2m deep pockmarks at 400 m depth,
200 kHz with 12ms FM.

This is equivalent to 0.6 ms CW in resolution

EM 2040 – Wide Band Multibeam
FM chirp

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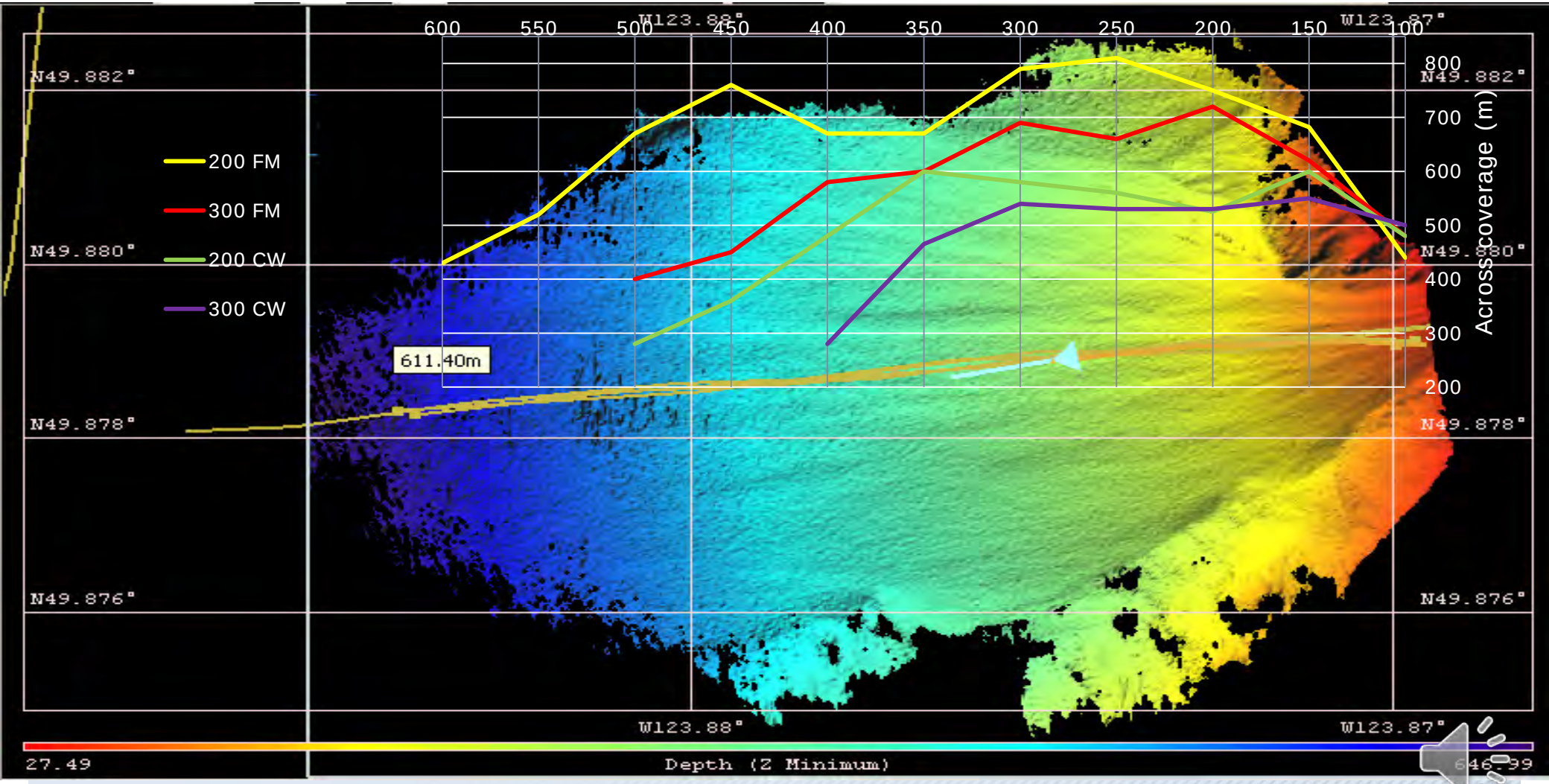
Performance test of EM 2040-04 Single RX at Jervis Inlet, vessel CHS Otter Bay, gravel seabed



EM 2040 – Wide Band Multibeam
Comparing EM 3002 and EM 2040

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Feature	EM 2040	EM 3002
Frequency	200 to 400 kHz	300 kHz
TX beam angle	0.4 and 0.7 deg	1.5 deg
RX beam angle	0.7 deg	1.5 deg
Swath per ping	2	1
No of beams	400 / 800 / 1600	254 / 508
Pulse type	CW and FM chirp	CW
Pulse length	25us to 12 ms	150, 400 us
Beam focusing	TX and RX	RX
Accuracy	1cm	5 cm
Stabilization	Yaw, pitch, roll	Roll, pitch
Sectors TX	3	1
Firmware	Latest generation beamformer	….

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EM 2040 – Wide Band Multibeam
Comparing EM 3002 and EM 2040

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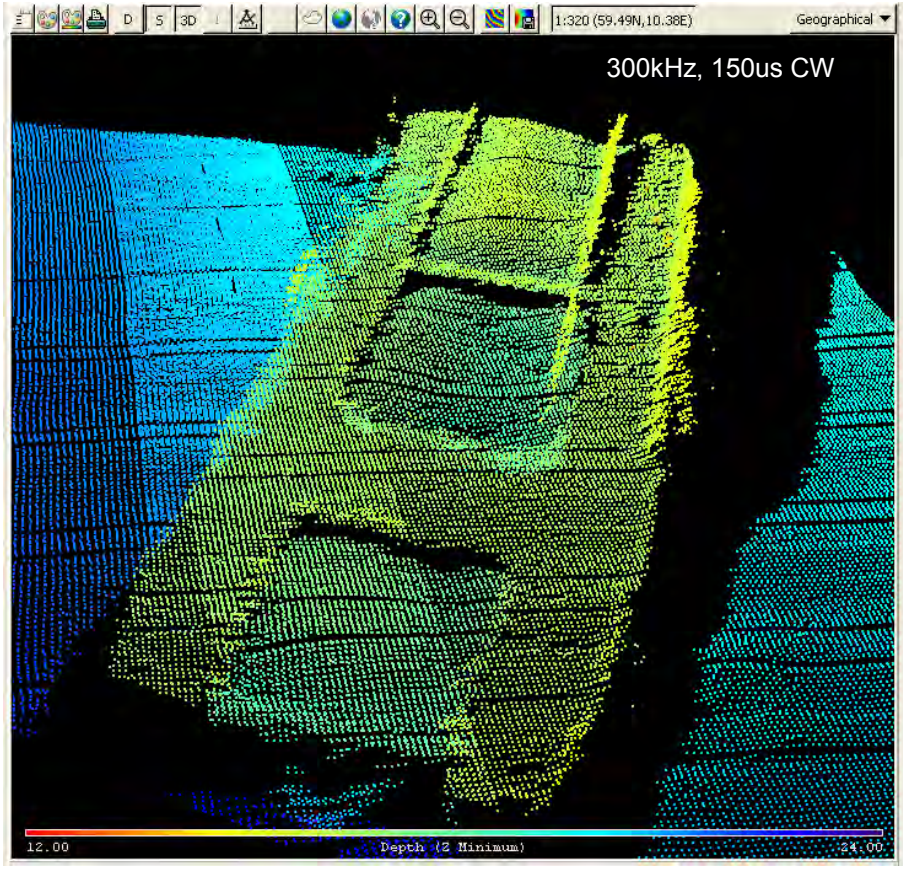
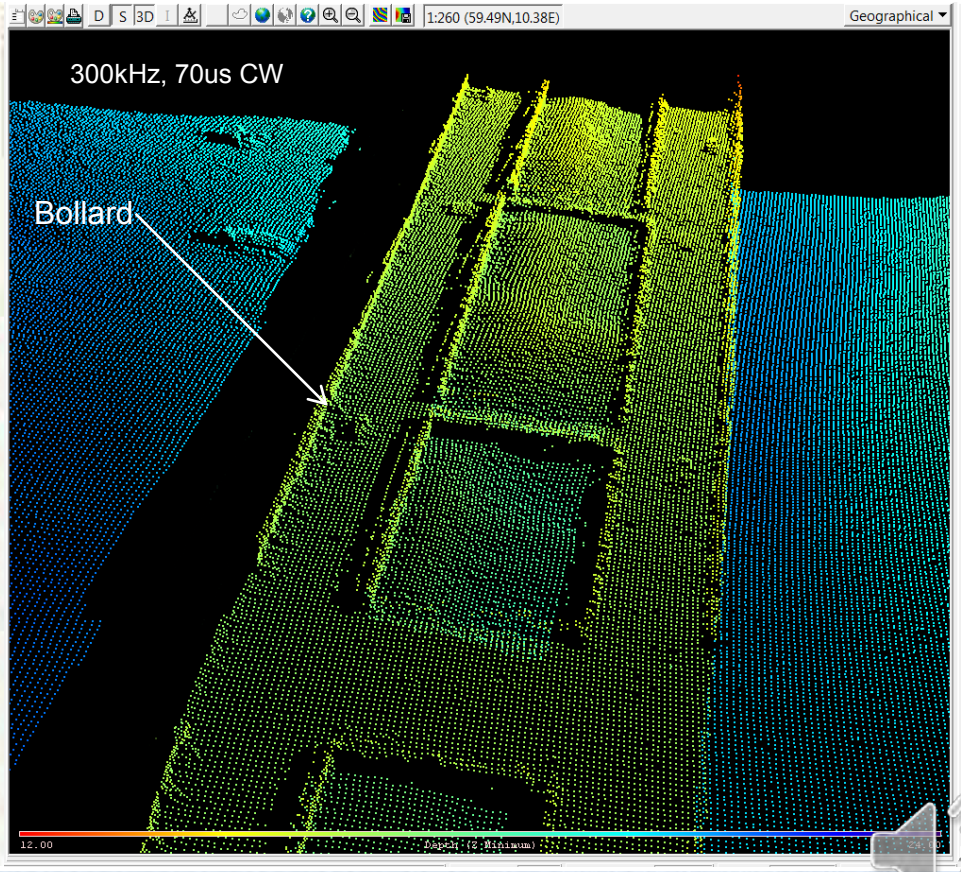
EM 3002
Dual head

EM 2040-07
Single RX





EM 2040 – Wide Band Multibeam
Comparing EM 3002 and EM 2040

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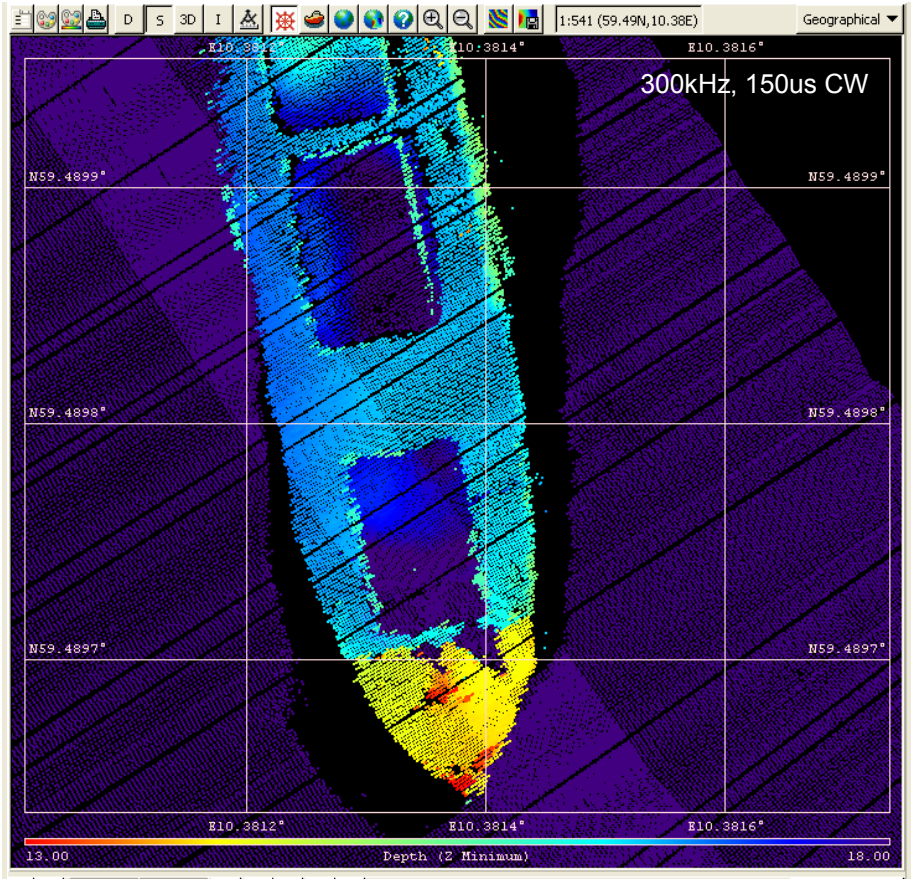
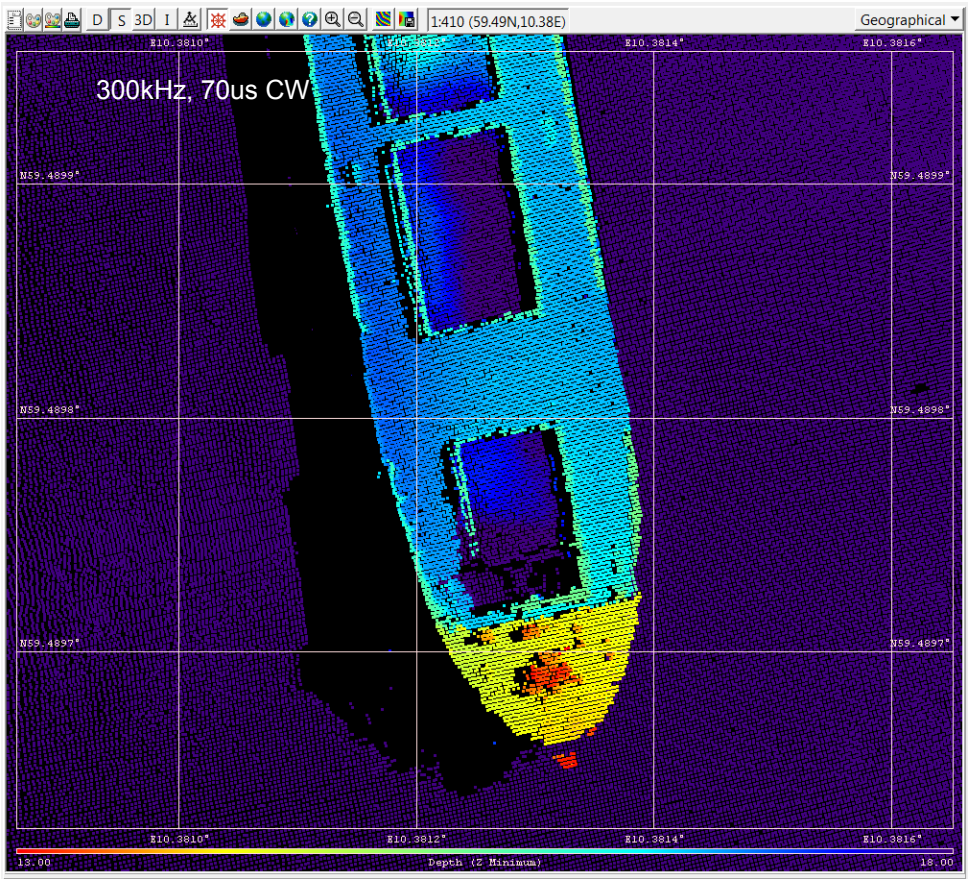
EM 3002
Dual head



EM 2040-07
Single RX



EM 2040 – Wide Band Multibeam
Comparing EM 3002 and EM 2040

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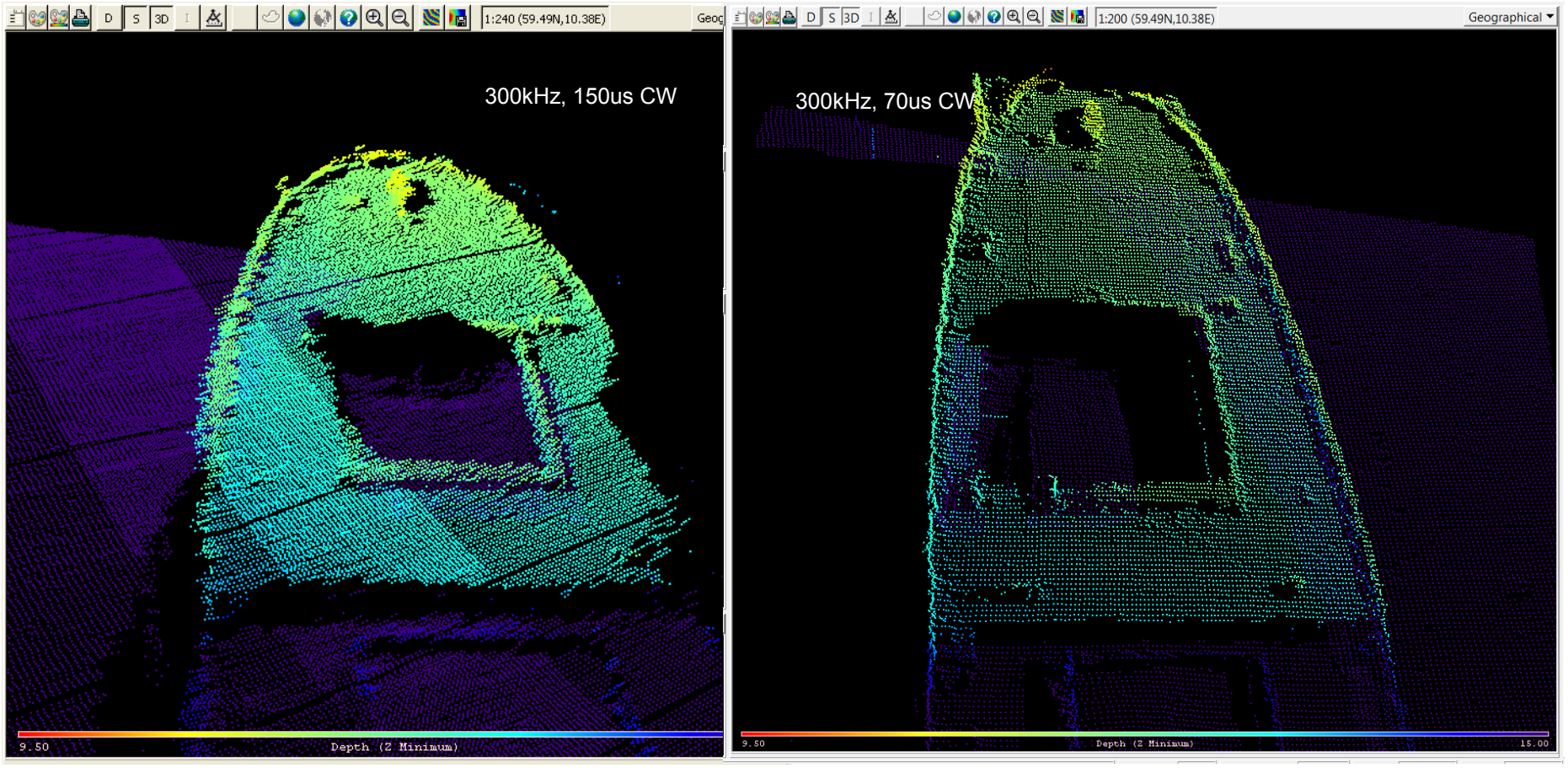
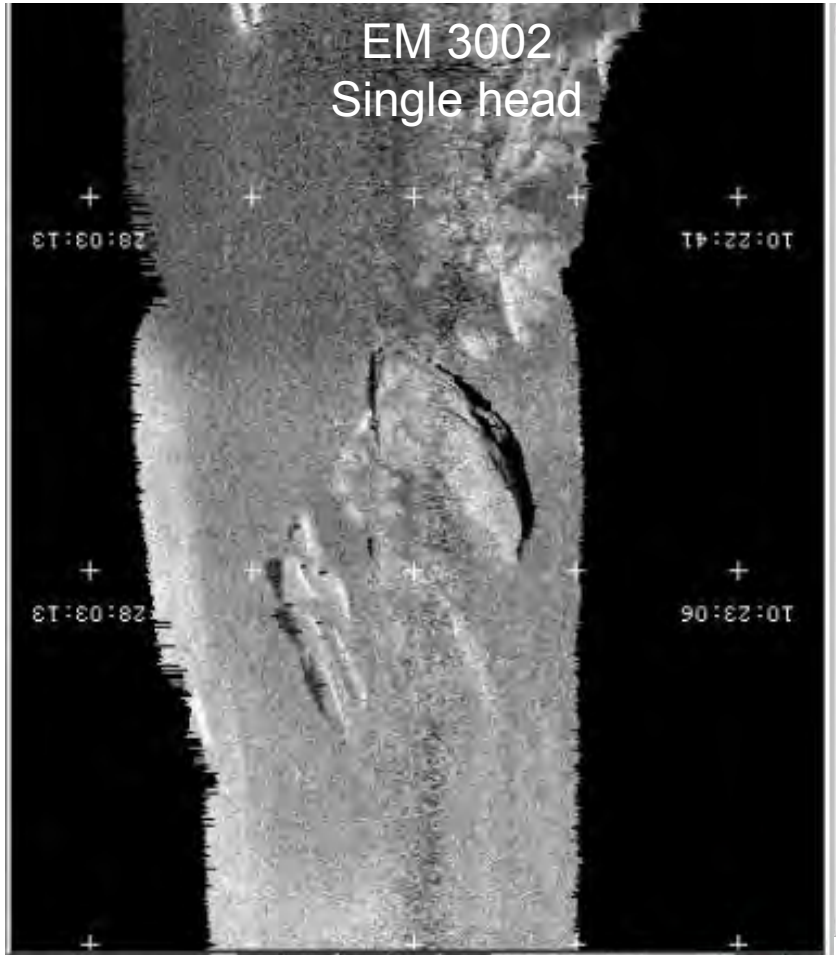
EM 3002
Dual head

EM 2040-07
Single RX



EM 2040 – Wide Band Multibeam
Comparing EM 3002 and EM 2040



EM 2040 – Wide Band Multibeam
The end of data cleaning

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It’s all about pretty images ….

EM 2040 – Wide Band Multibeam
The end of data cleaning

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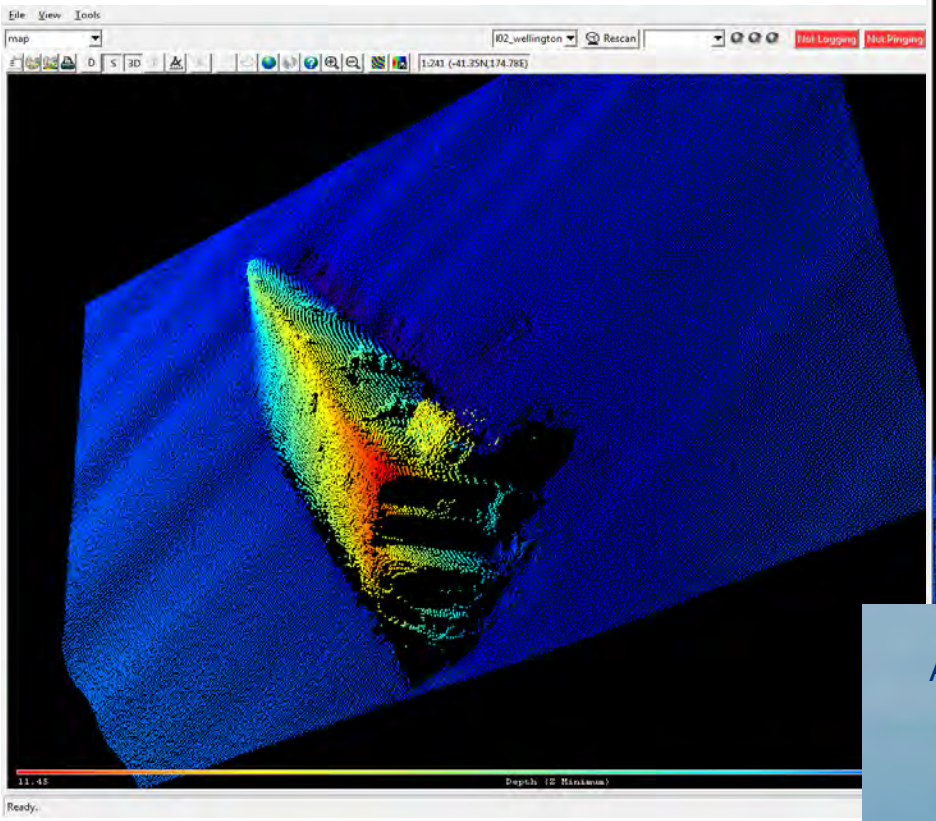
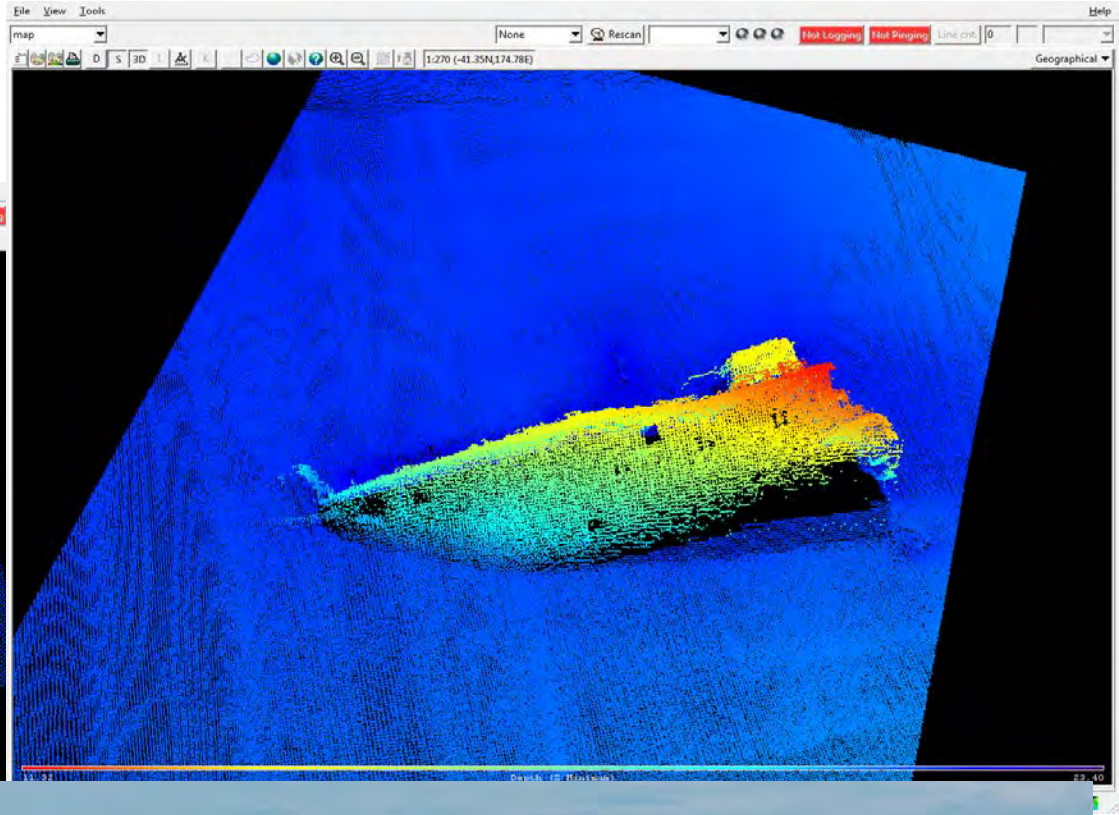
All points in SIS in real-time.

Raw data with no data cleaning.





KONGSBERG PROPRIETARY – See Statement of Proprietary Information

EM 2040 – Wide Band Multibeam
The end of data cleaning

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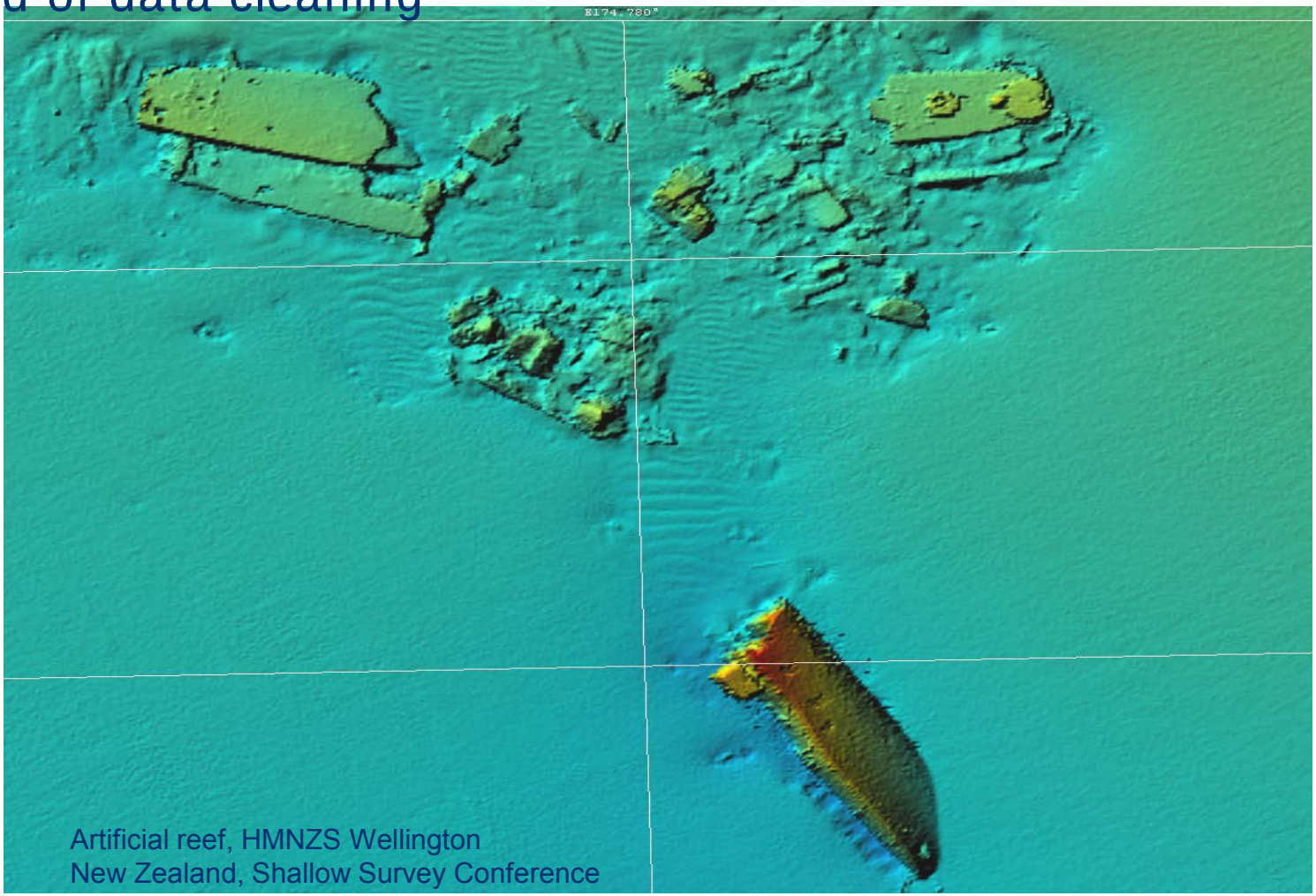
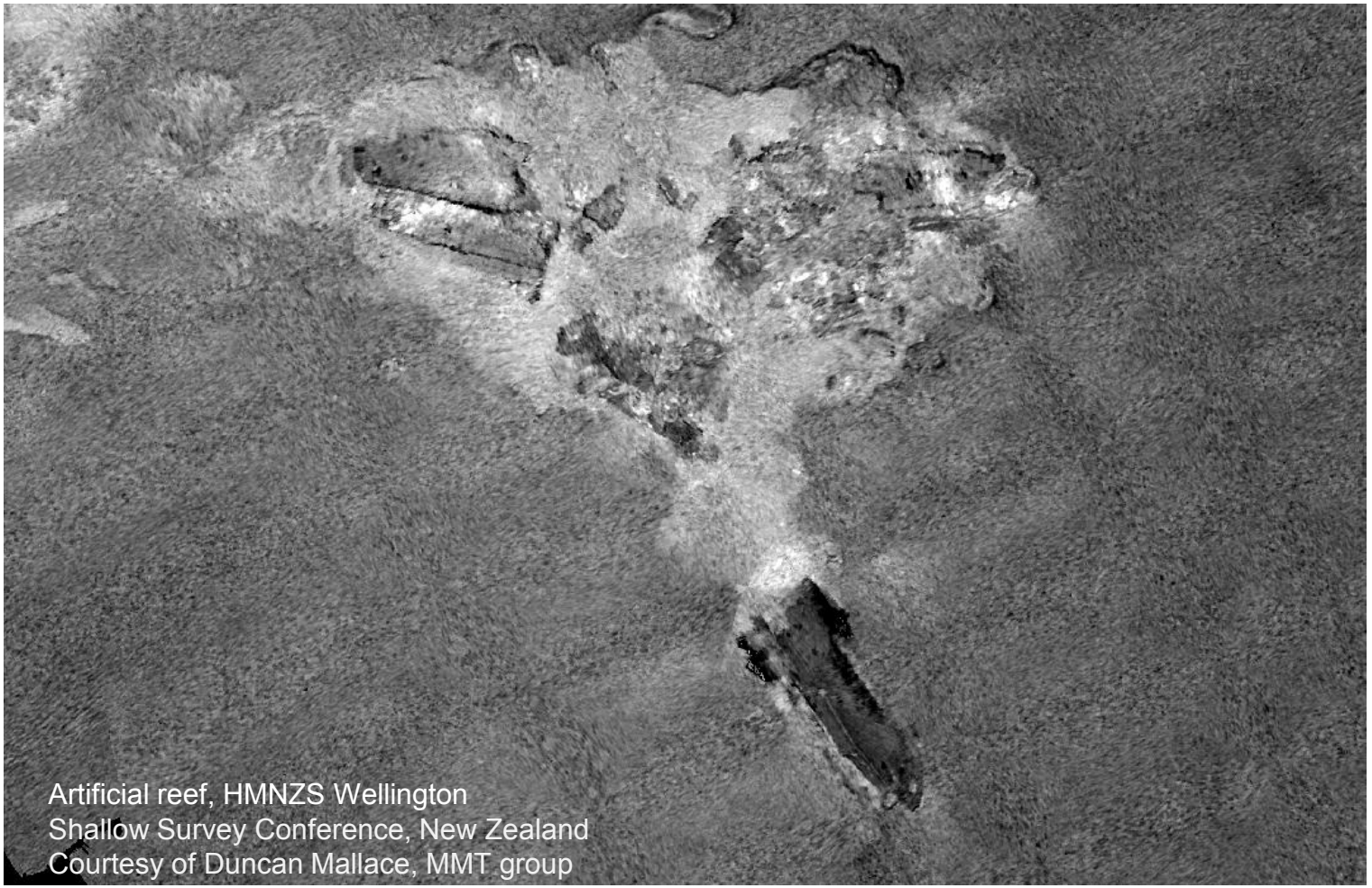


Bathymetry image
HMNZS Wellington Wreck – 20 m depth, 0.5 m grid

EM 2040 – Wide Band Multibeam
The end of data cleaning

KONGSBERG



Seabed Backscatter Imagery
HMNZS Wellington Wreck – 10cm mosaic

EM 2040 – Wide Band Multibeam
The end of data cleaning

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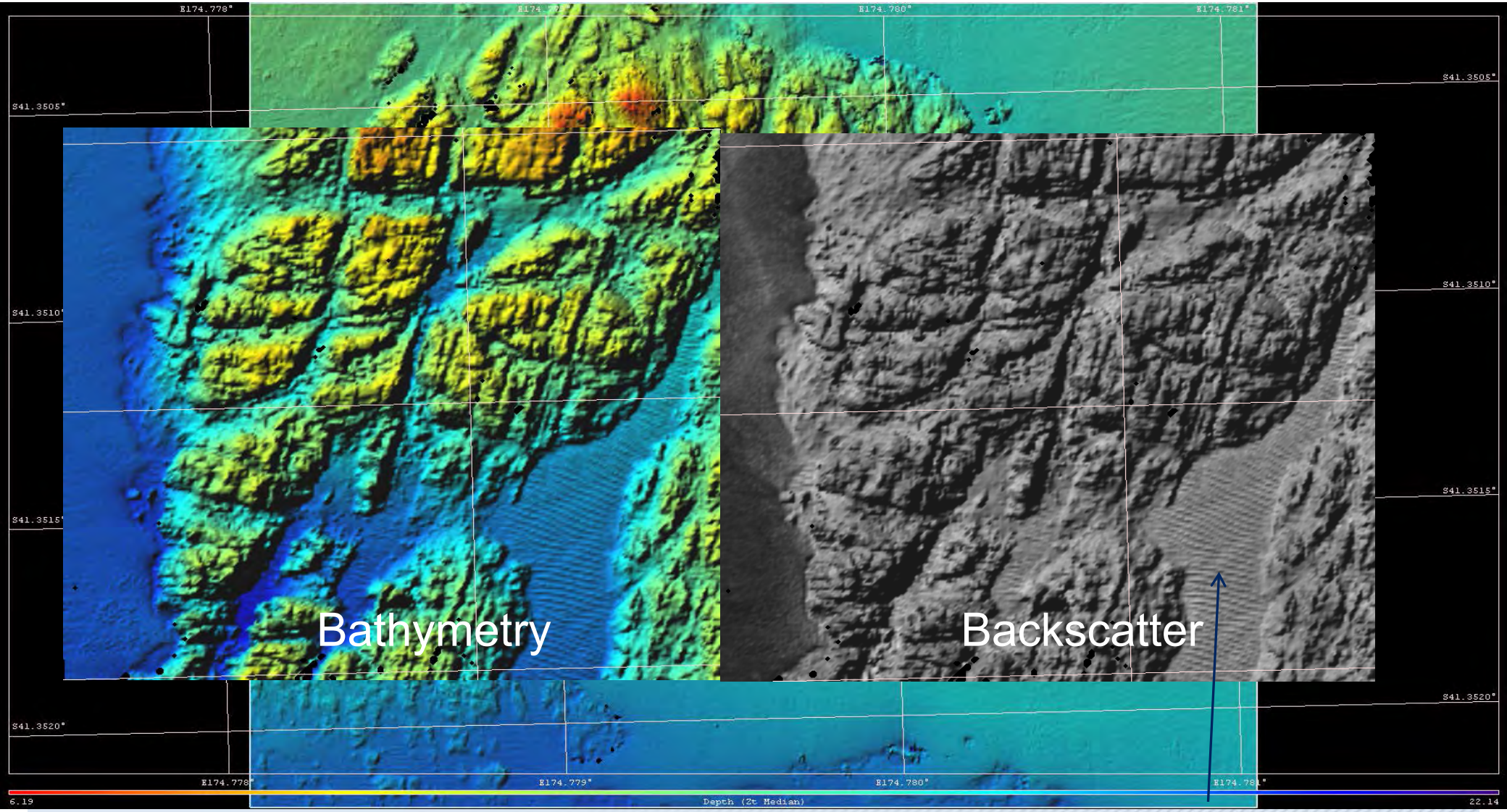
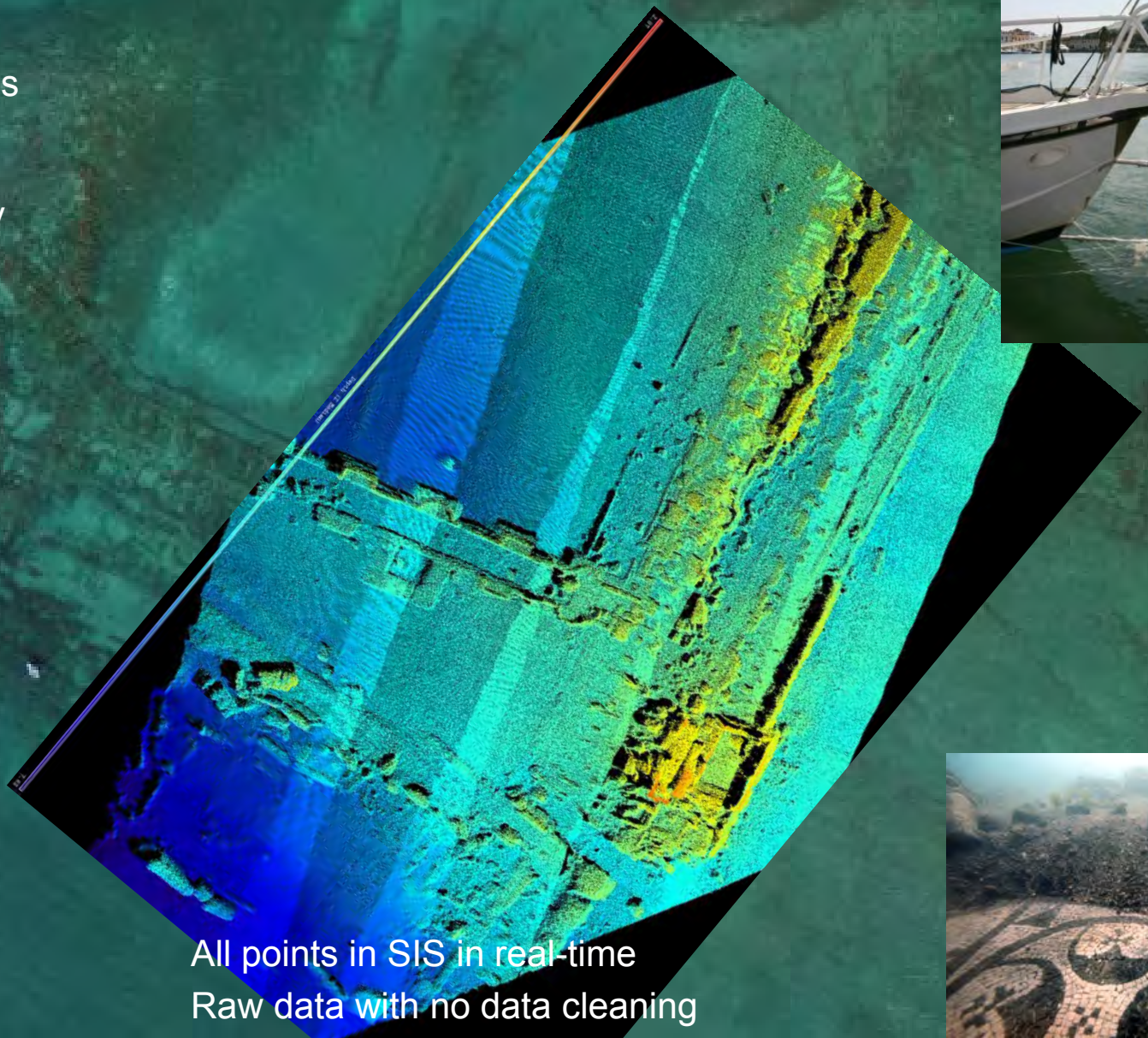


Sand waves 8 cm at 15 m depth

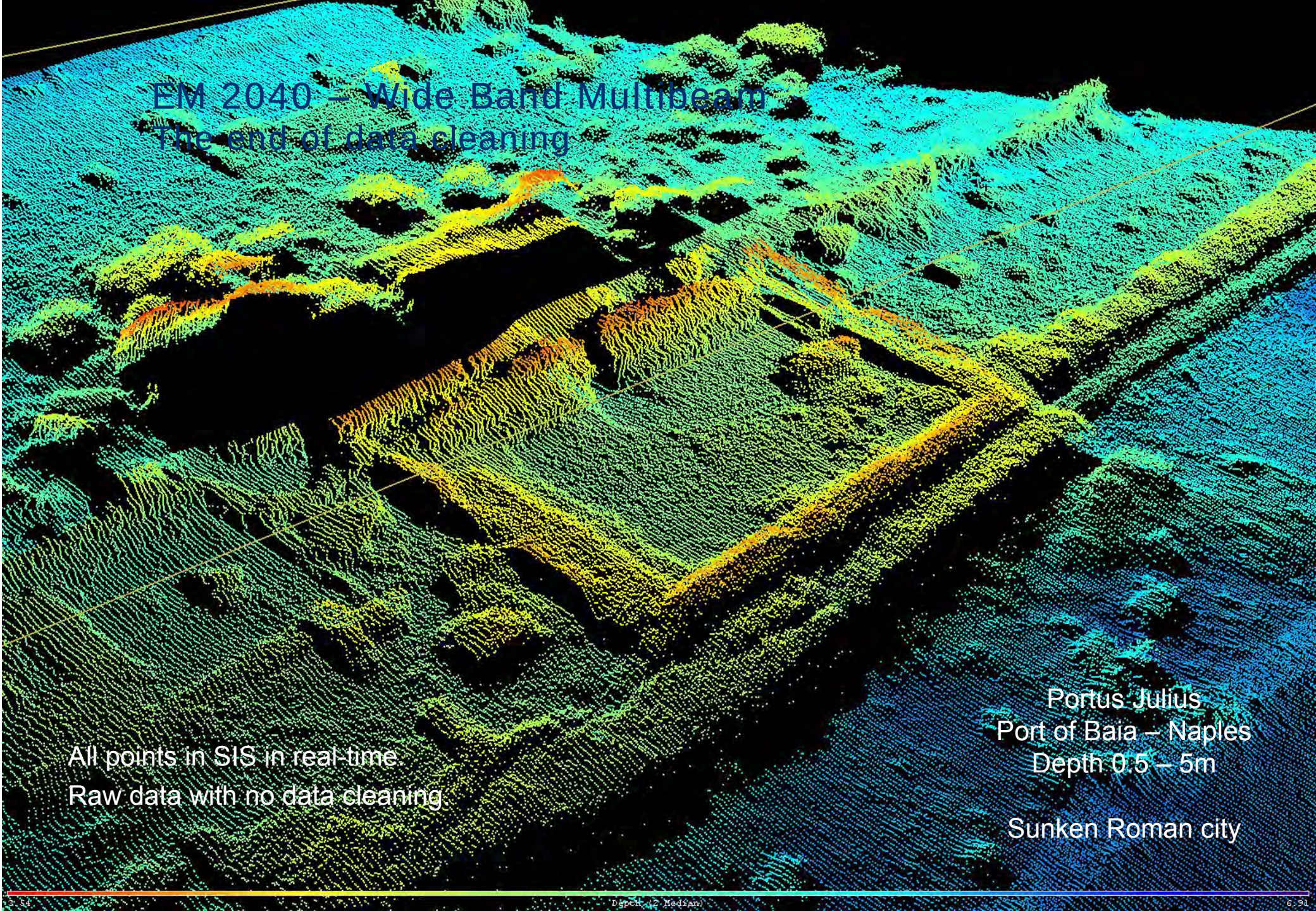
EM 2040 – Wide Band Multibeam
The end of data cleaning

Portus Julius
Port of Baia – Naples
Depth 0.5 – 5m

Sunken Roman city

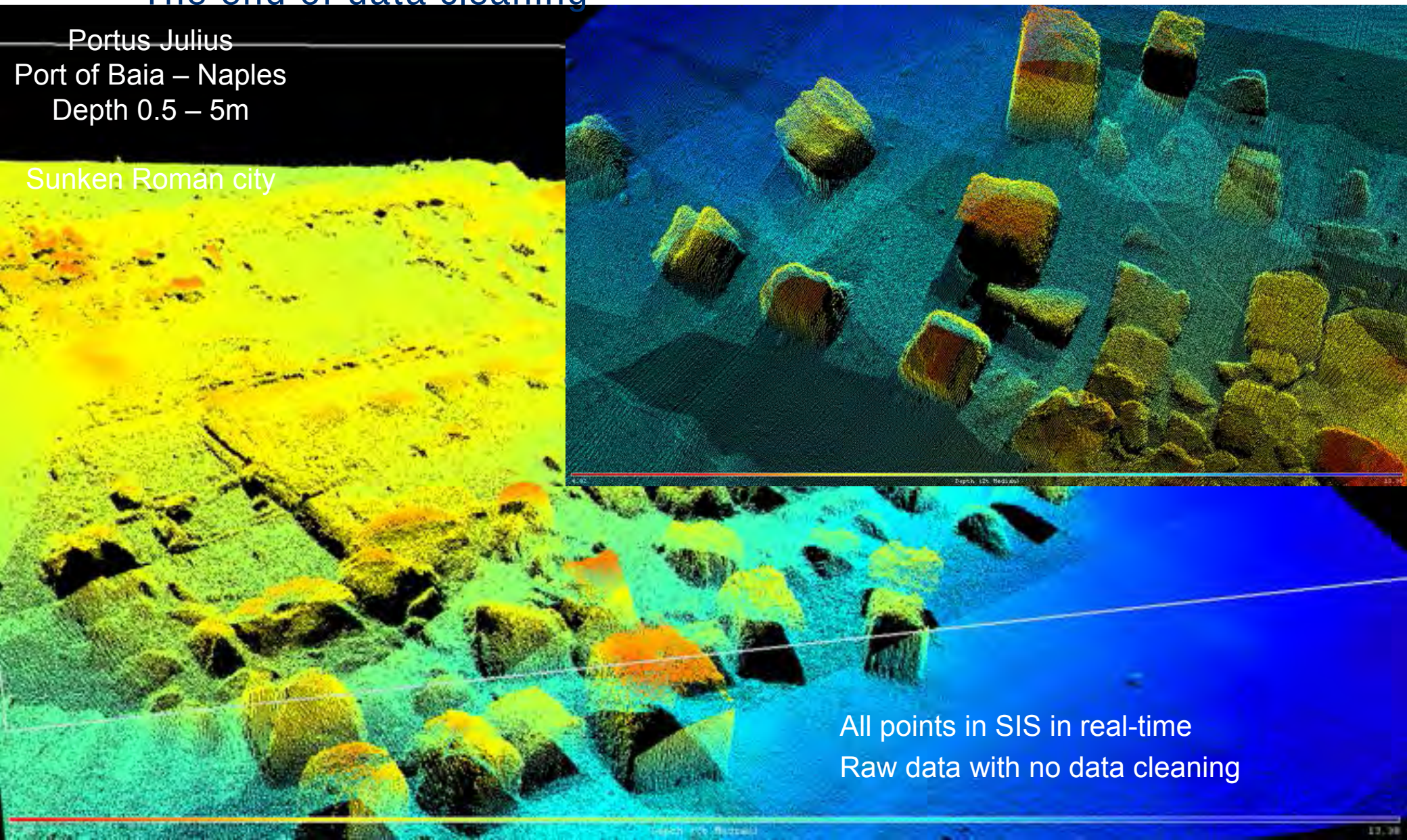


All points in SIS in real-time
Raw data with no data cleaning


EM 2040 – Wide Band Multibeam
The end of data cleaning
All points in SIS in real-time.
Raw data with no data cleaning.
Portus Julius
Port of Baia – Naples
Depth 0.5 – 5m
Sunken Roman city
Depth (re Median)

EM 2040 – Wide Band Multibeam
The end of data cleaning

KONGSBERG



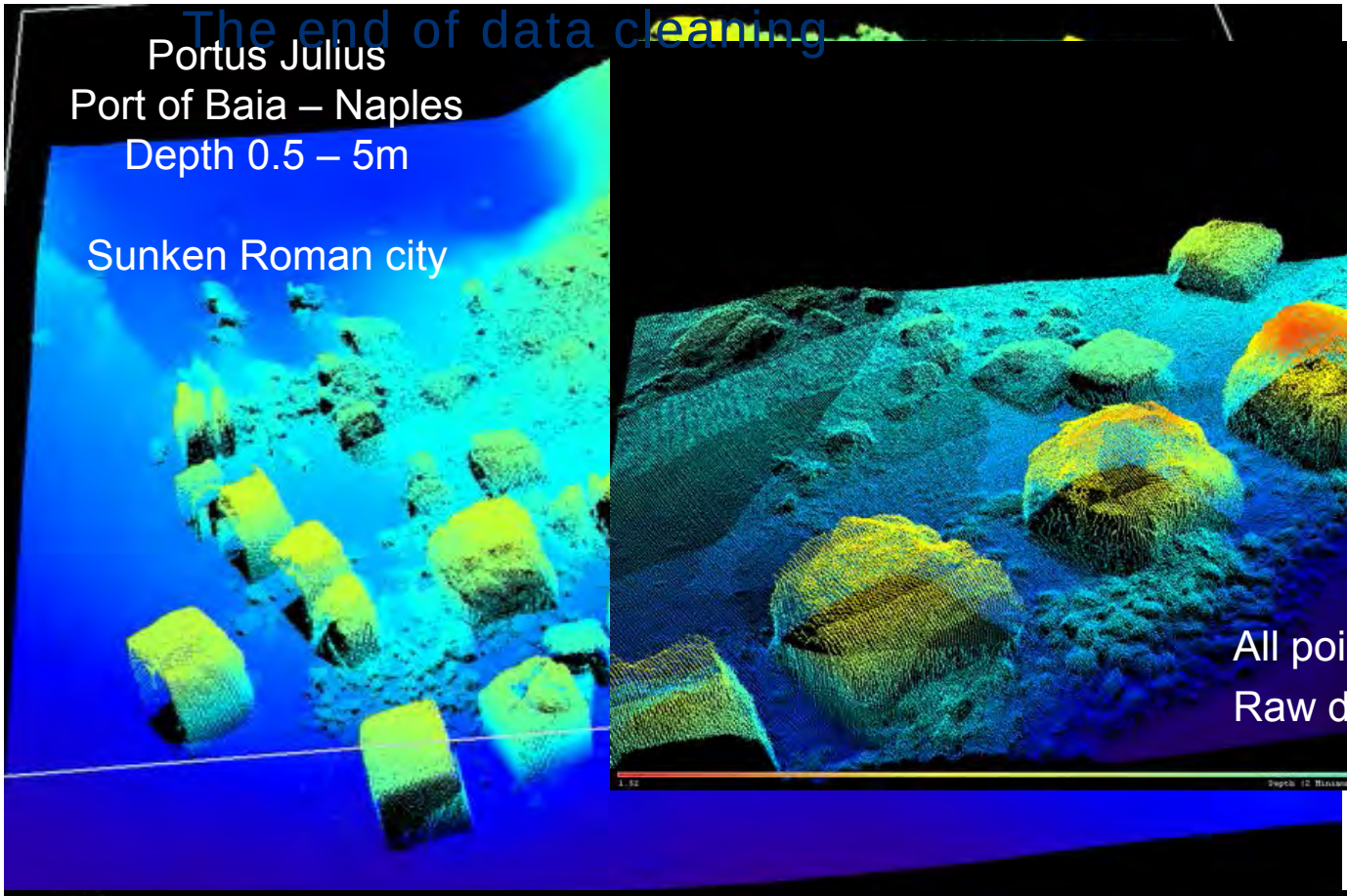
EM 2040 – Wide Band Multibeam

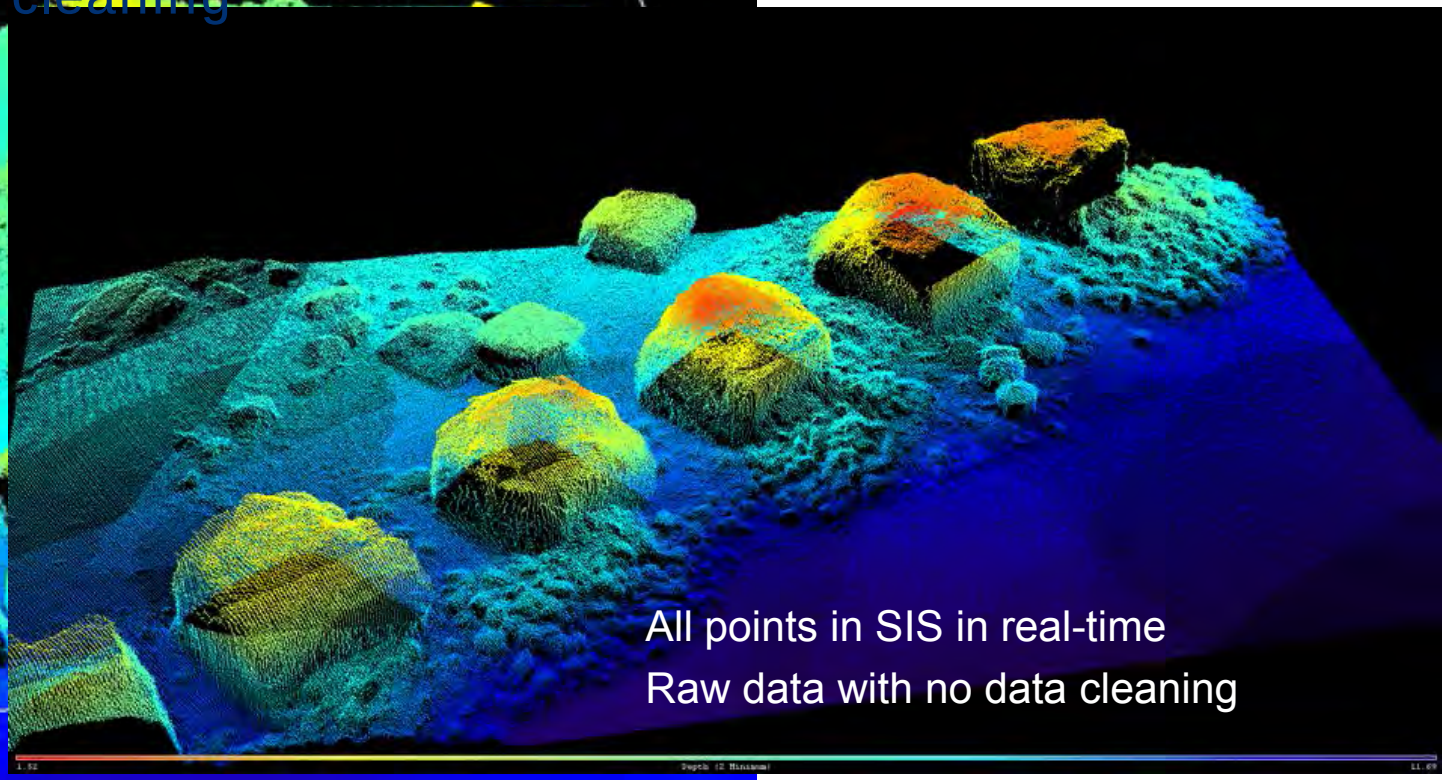
The end of data cleaning

KONGSBERG

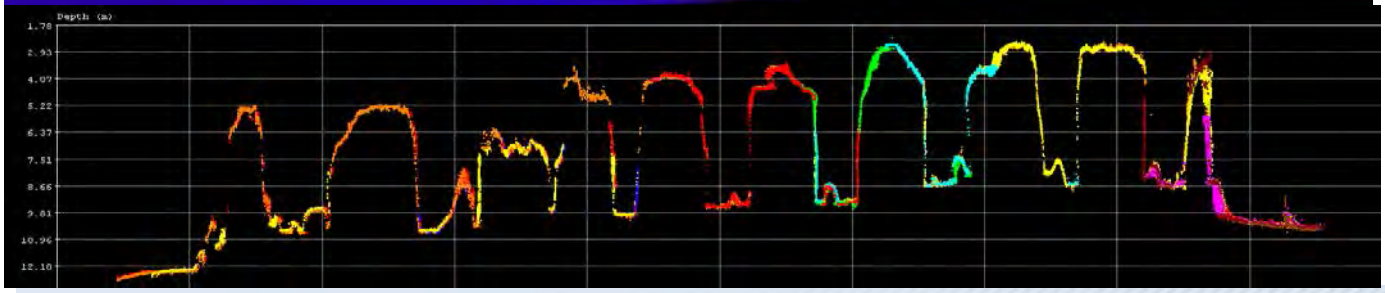
Portus Julius
Port of Baia – Naples
Depth 0.5 – 5m

Sunken Roman city



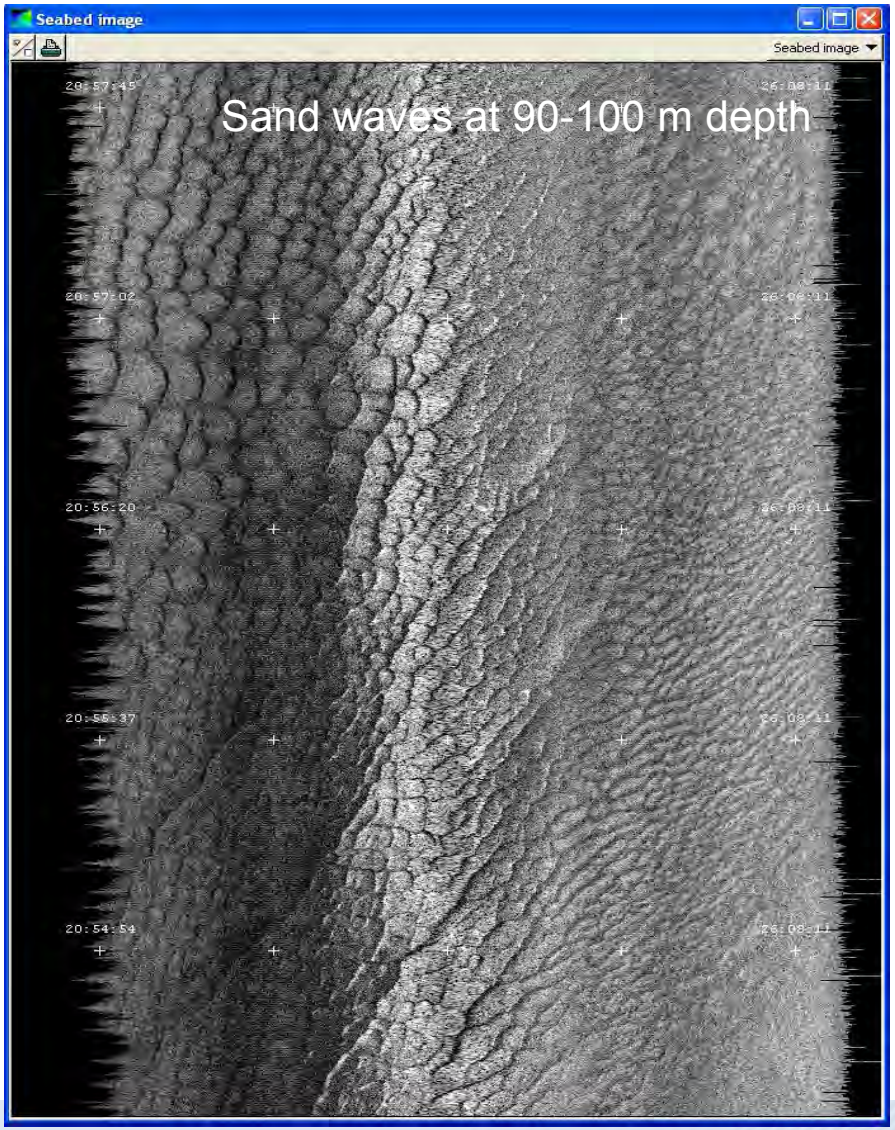


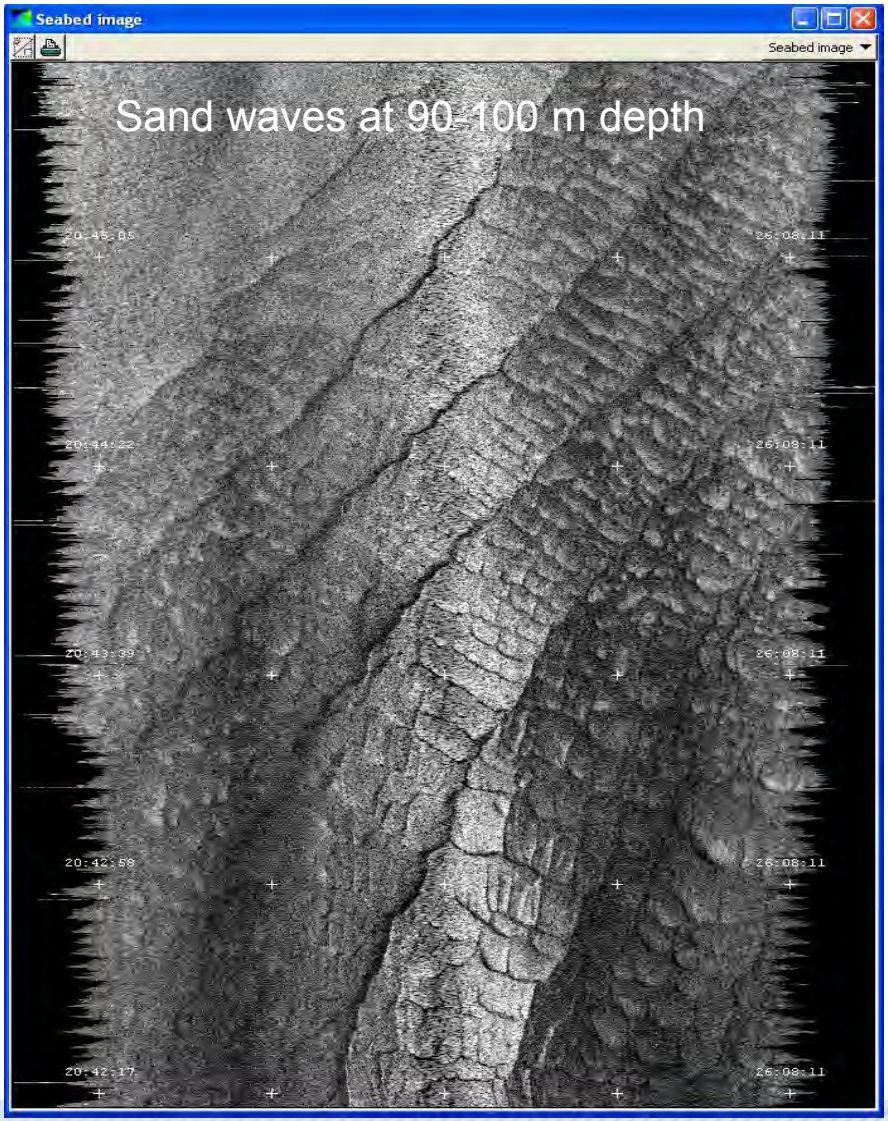
All points in SIS in real-time
Raw data with no data cleaning



EM 2040 – Wide Band Multibeam
Seabed image

KONGSBERG





EM 2040 – Wide Band Multibeam
Water column

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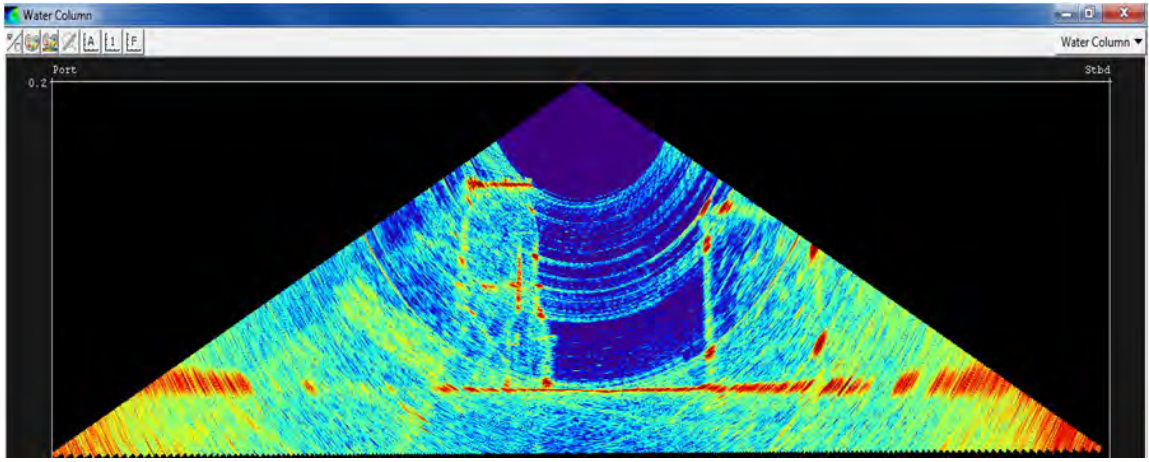
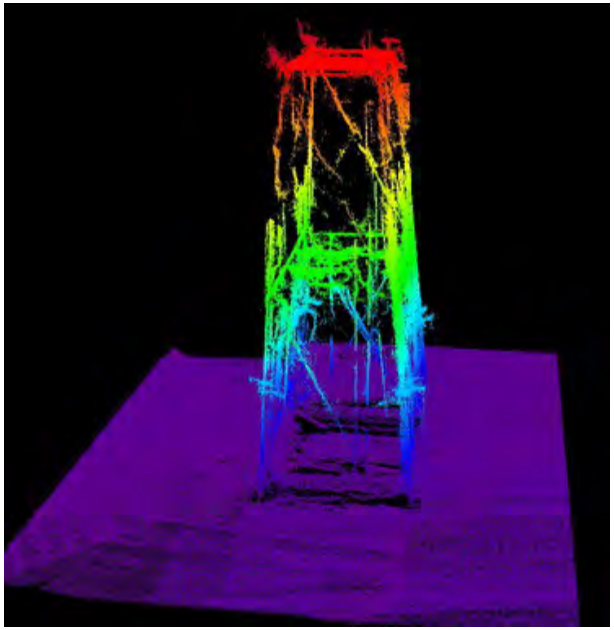
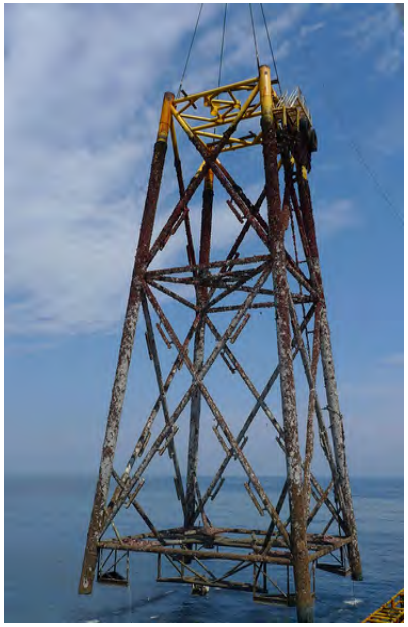
EM 2040 ROV test, Gulf of Mexico

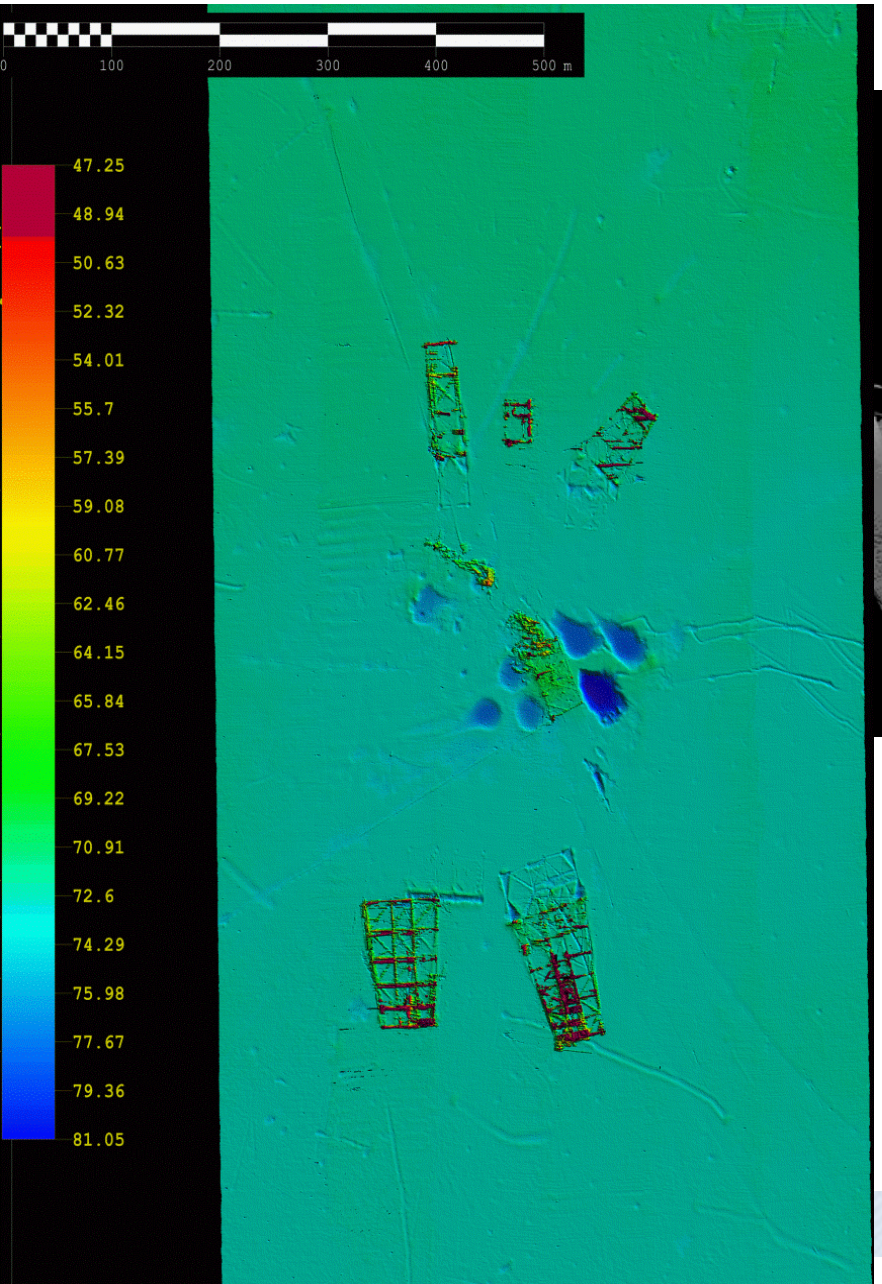




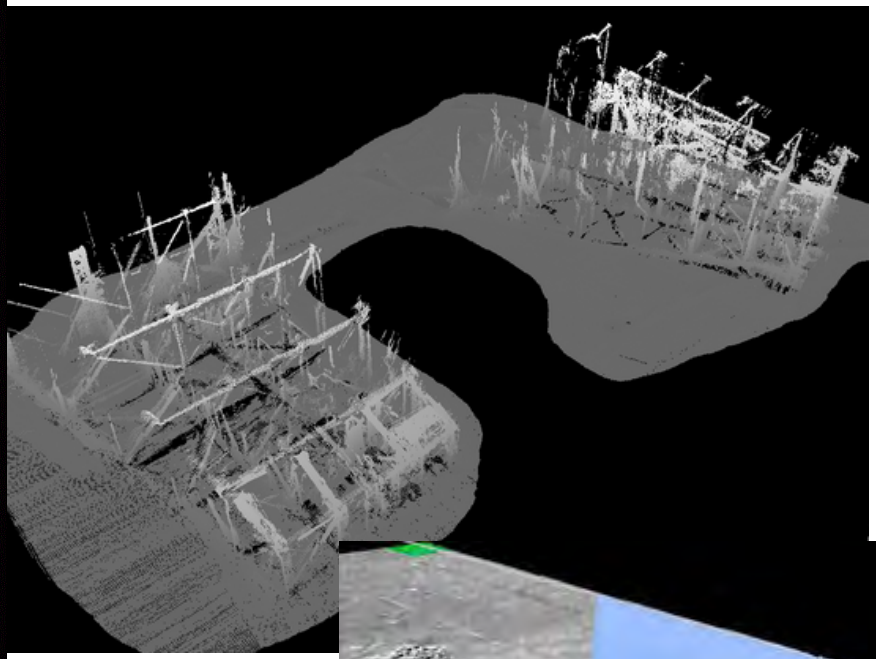


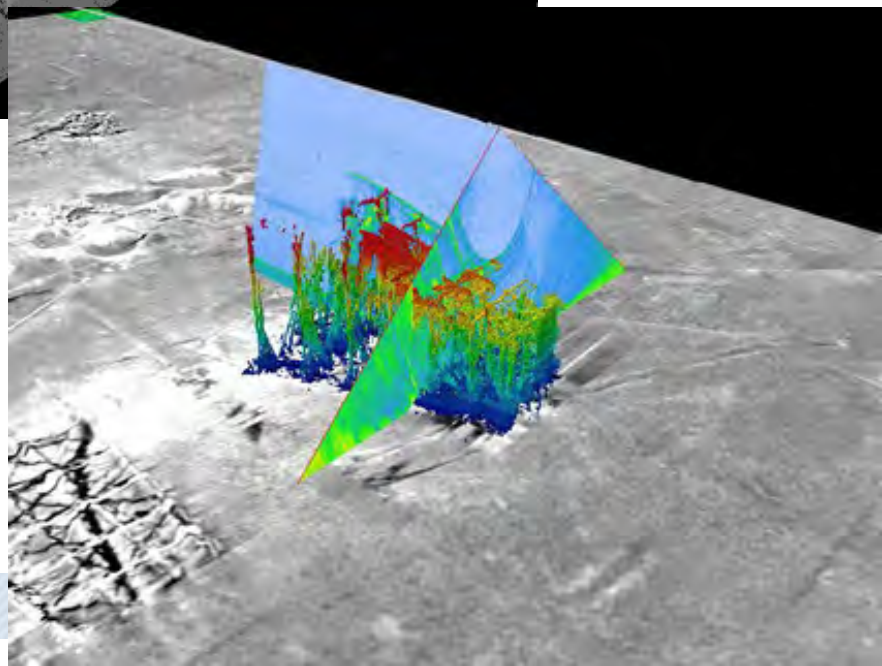
EM 2040 – Wide Band Multibeam

KONGSBERG



EM 2040 ROV demo in Gulf of Mexico





EM 2040 – Wide Band Multibeam
Water column

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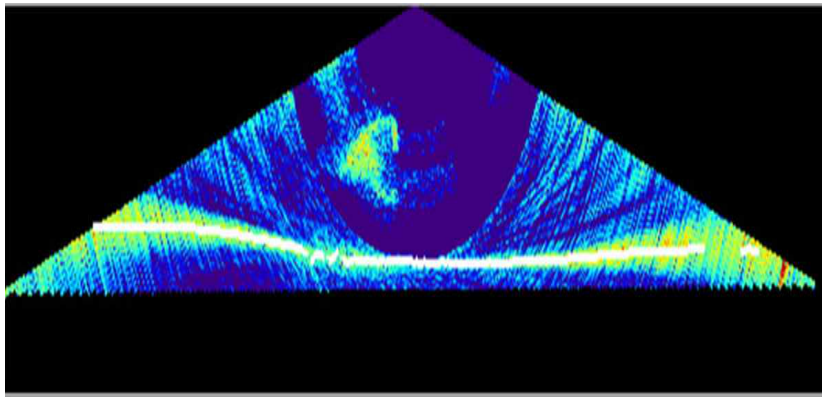
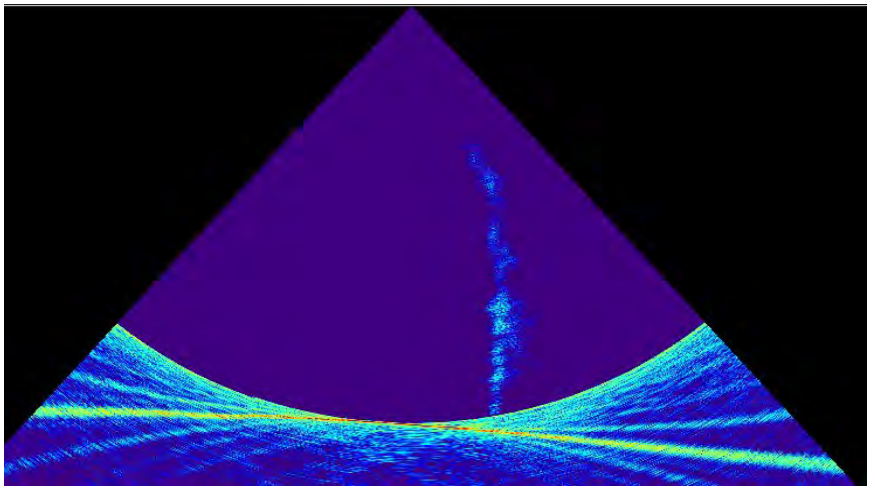
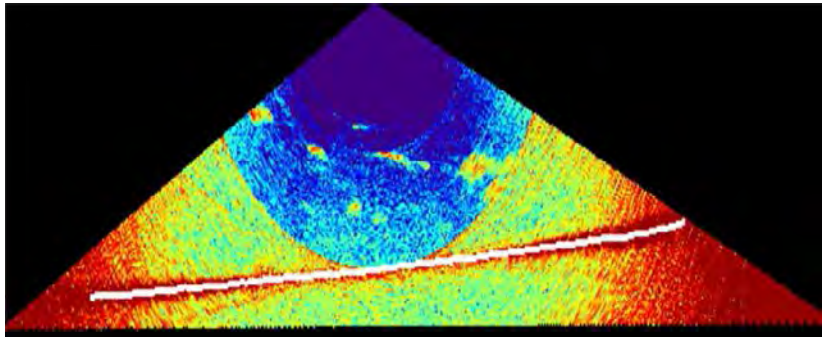
School of fish

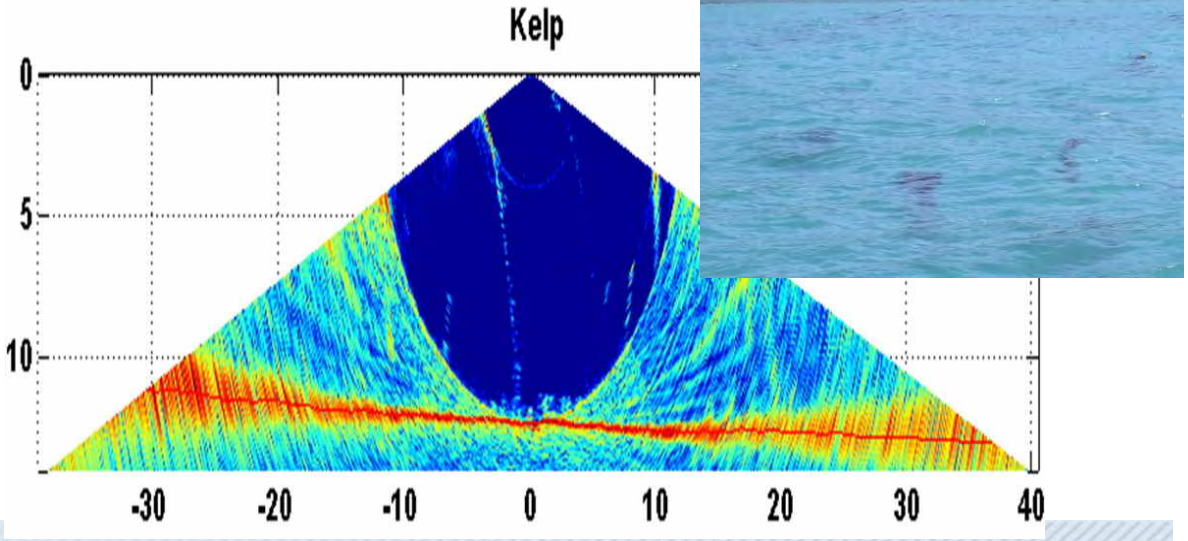


Gas leak detection



School of fish

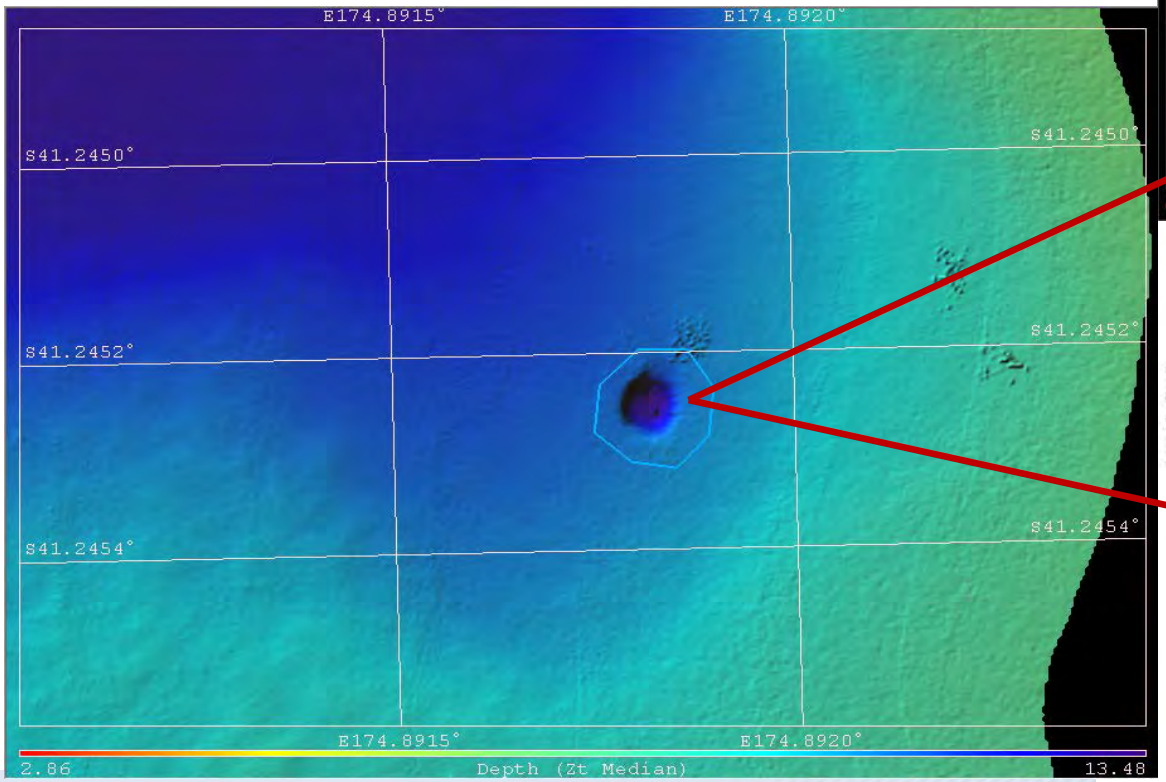


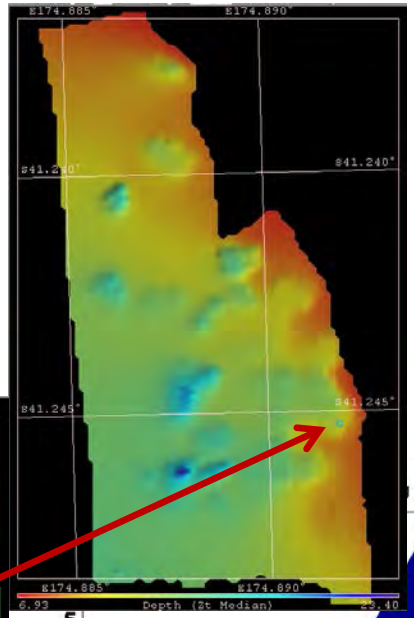


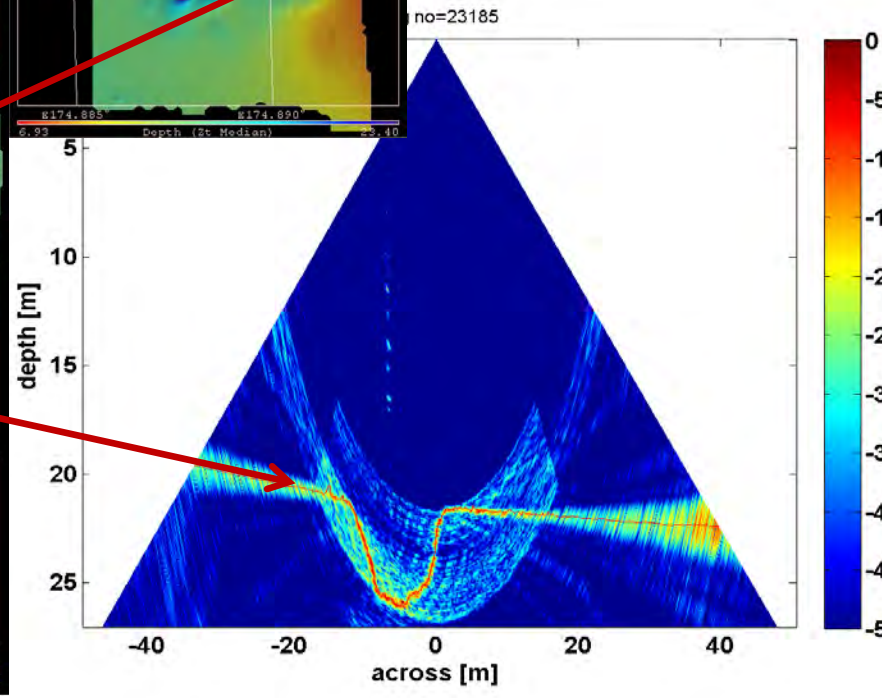
EM 2040 – Wide Band Multibeam
Water column

Fresh water seep, Shallow survey 2012,
Hutt river mouth, New Zealand

The seep is 2 m deep and 6.5m wide at top







WORLD CLASS - through people, technology and dedication.

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EM 2040 – Wide Band Multibeam
Water column

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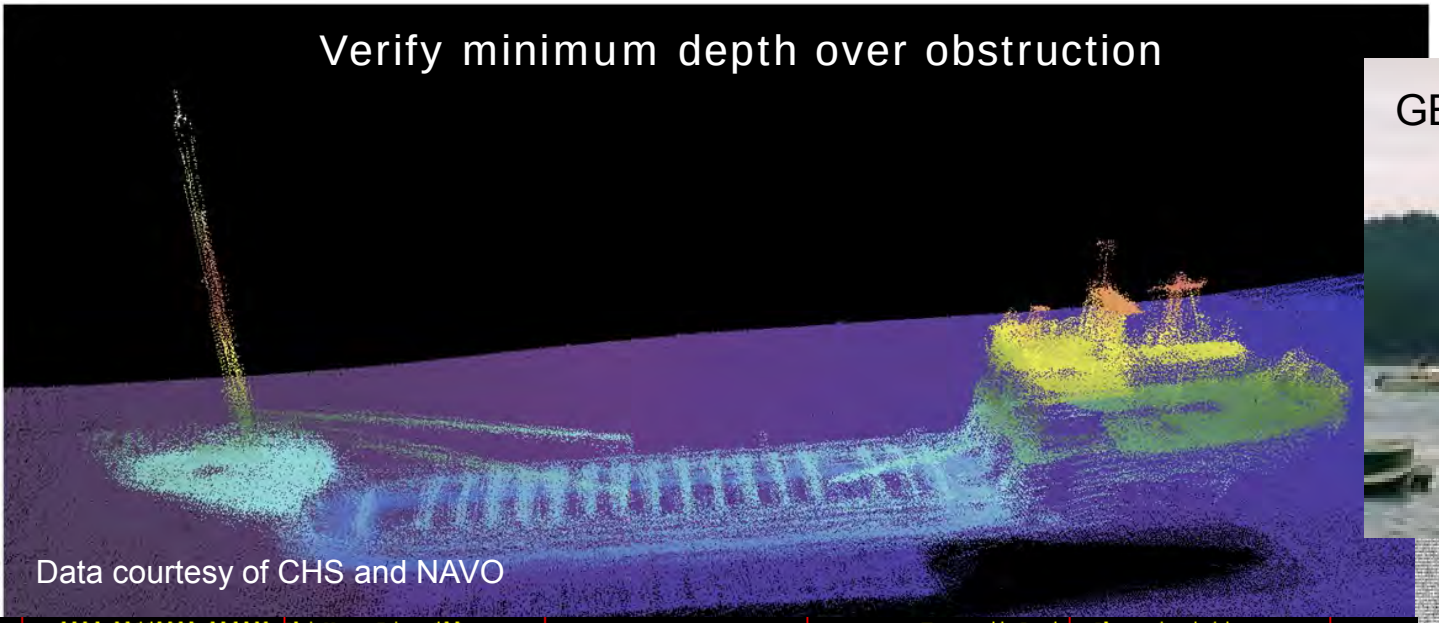

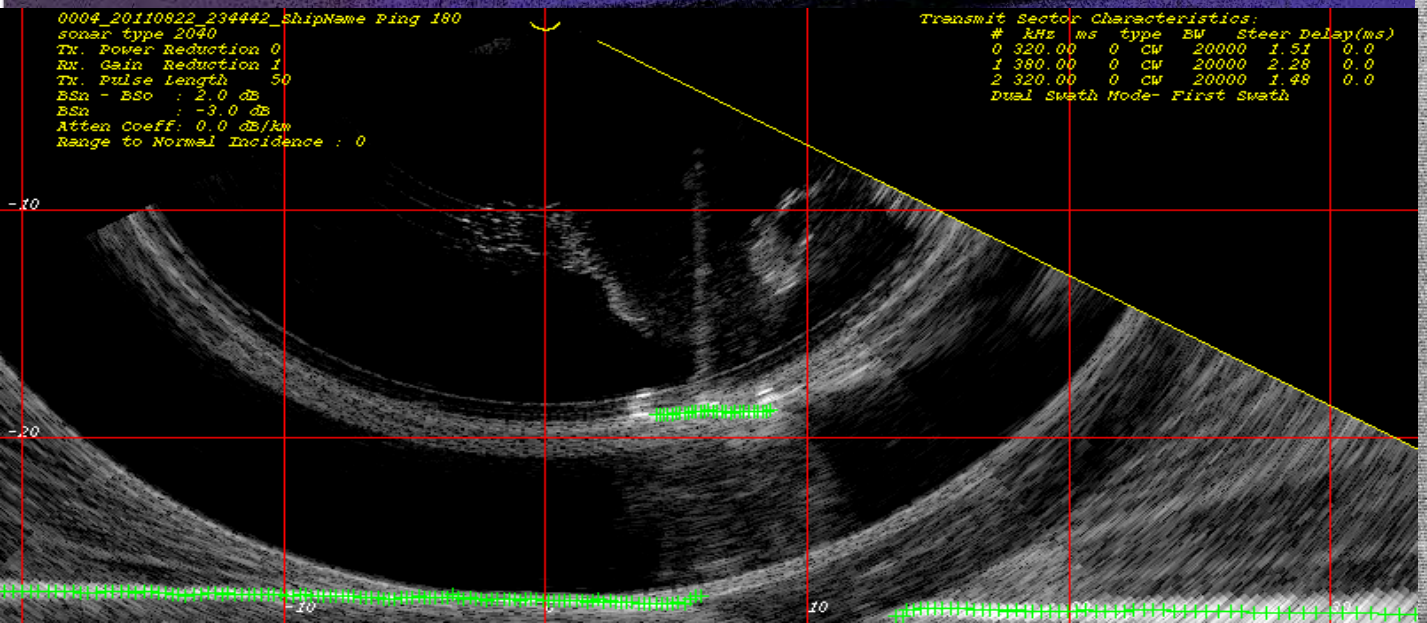

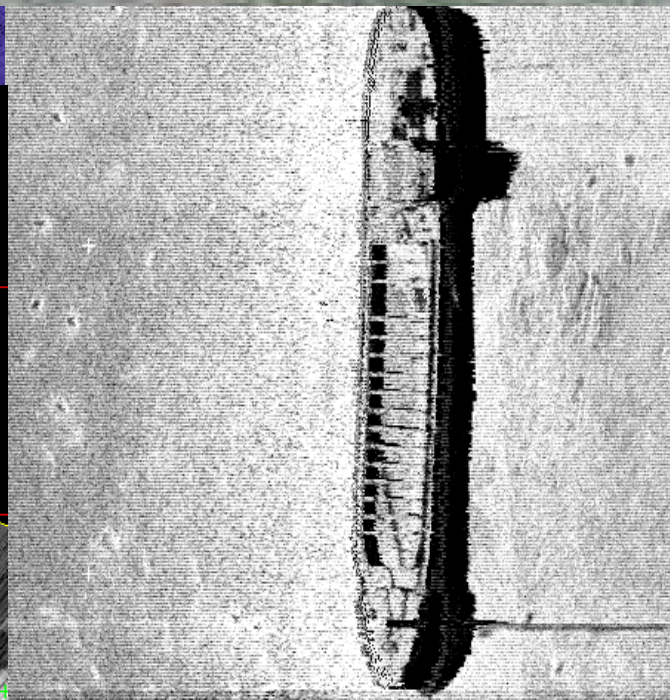

EM 2040 – Wide Band Multibeam
Water column

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EM 2040 – Wide Band Multibeam
Water column

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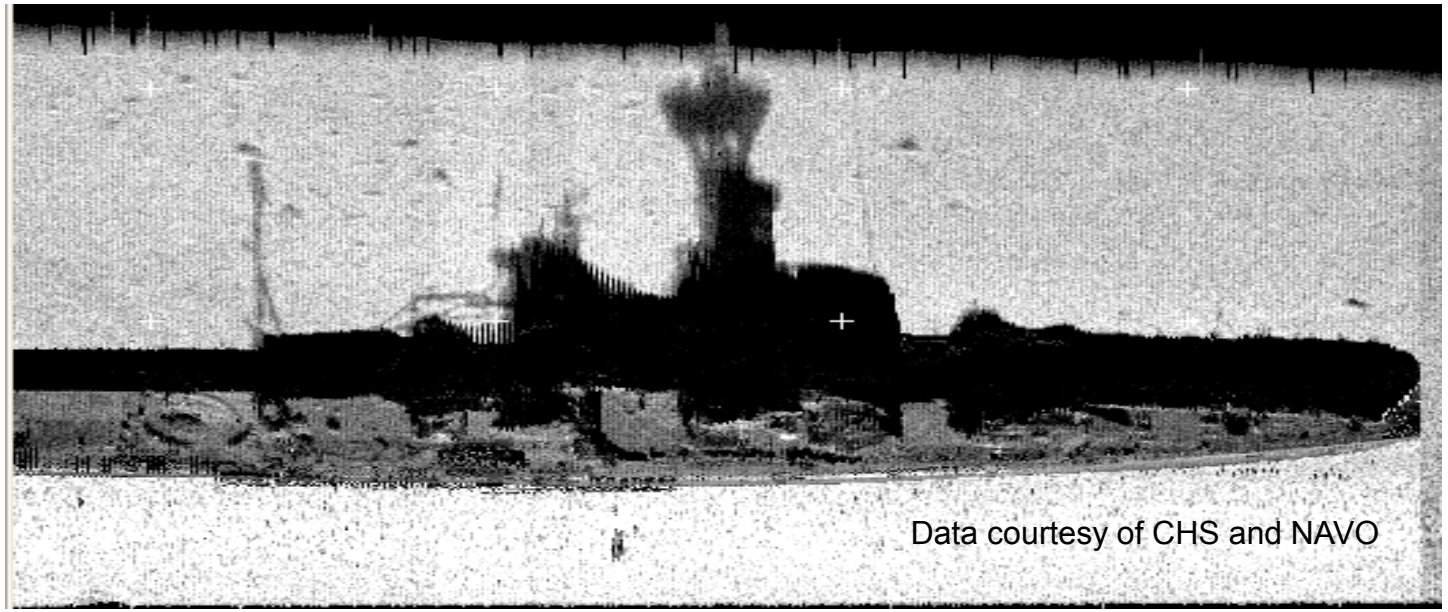
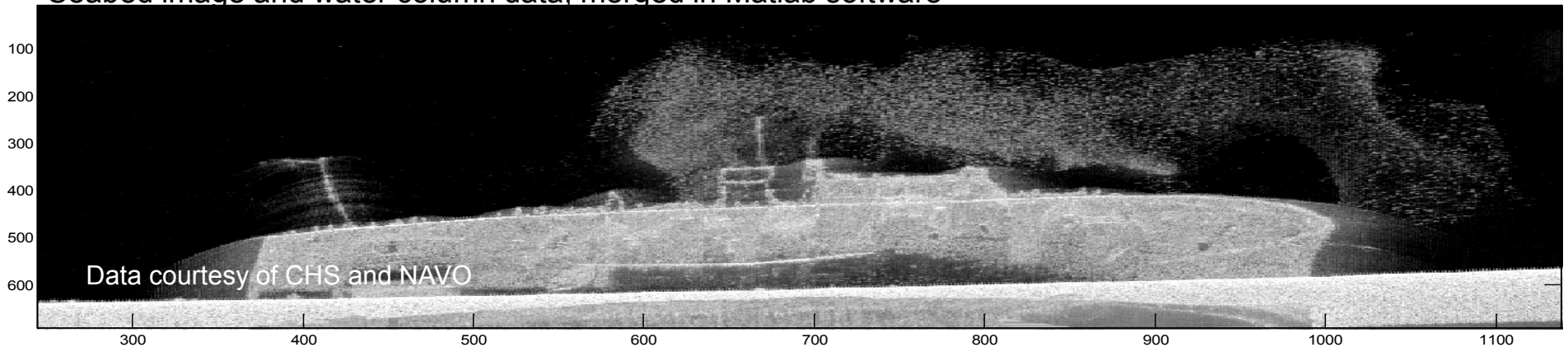
EM 2040-04.
HMCS MacKenzie.
Real-time seabed image in SIS.



Seabed image and water column data, merged in Matlab software



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Installation examples

EM 2040 – Wide Band Multibeam Installation

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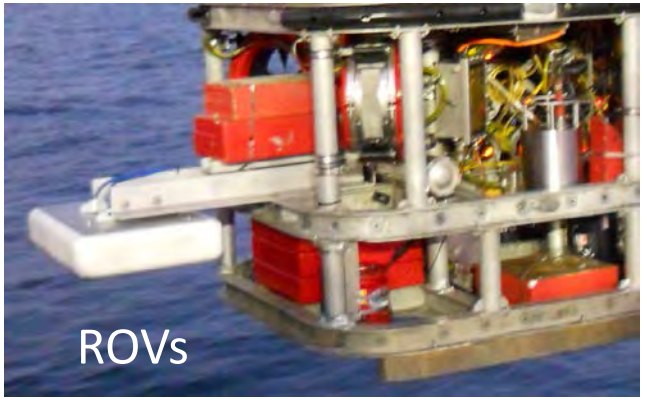
AUVs
(HUGIN with HiSAS and EM 2040)



EM 2040 – Wide Band Multibeam
Installation - portable solutions

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EM 2040 – Wide Band Multibeam
Installation – hull units

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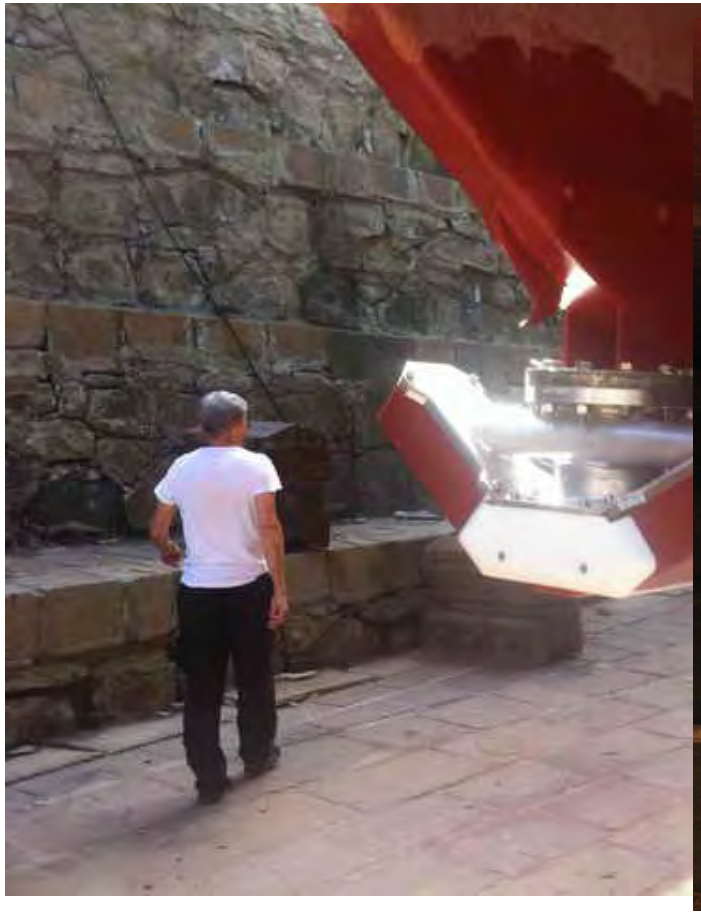
Hull mount – 0.7x0.7 degree dual RX system



Hull unit - 0.7x0.7 degree dual RX system
(Int. diameter approx. 1100mm)

EM 2040 – Wide Band Multibeam
Installation – blister and flush mount

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Flush hull mount – 0.4x0.7degrees - dual RX system

Gondola mount – 0.4x0.7degrees

0.4x0.7deg dual RX

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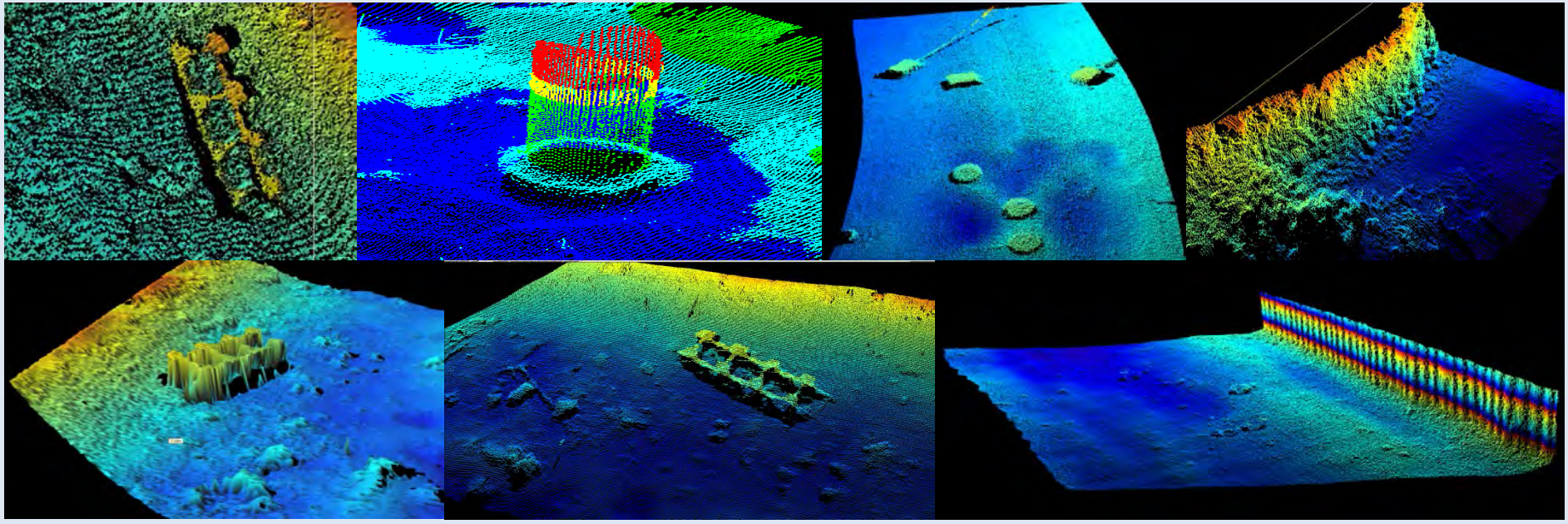
Revolution in Resolution

EM 2040 Wideband multibeam

Thanks