



Fugro's Hydrographic Services

Presentation to ROPME Sea Area Hydrographic Commission, Meeting 7, Muscat
21 February, 2017.

Overview of Fugro's Hydrographic Services

Fugro:

- 11,500 employees
- 60 countries
- ~200 offices
- 54 years exploring the earth

Two divisions within Fugro

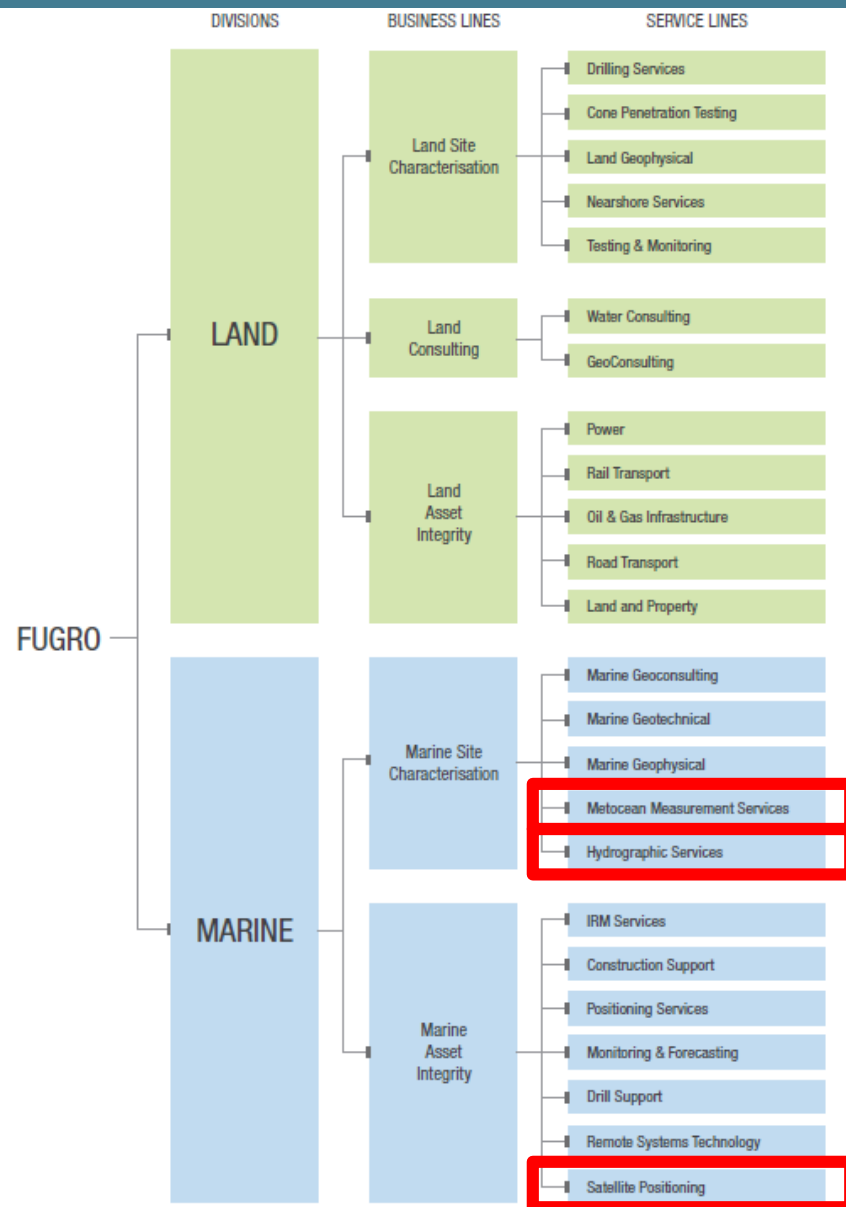
- Marine
- Land

Local Presence – Global Reach

Fugro's regional office based in Abu Dhabi (**UAE**) with local offices in **Oman, Qatar, Saudi Arabia, Kuwait, and Pakistan**

Provide Hydrographic Survey services with support from specialist operating companies worldwide including:

- Germany (Fugro OSEA GmbH.)
- Australia (Fugro LADS Corporation Pty. Ltd.)
- United States (Fugro Pelagos, Inc.)

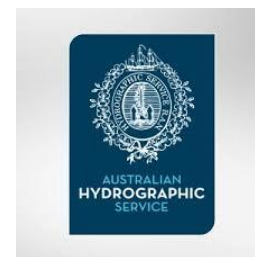


Fugro's Hydrography services include:

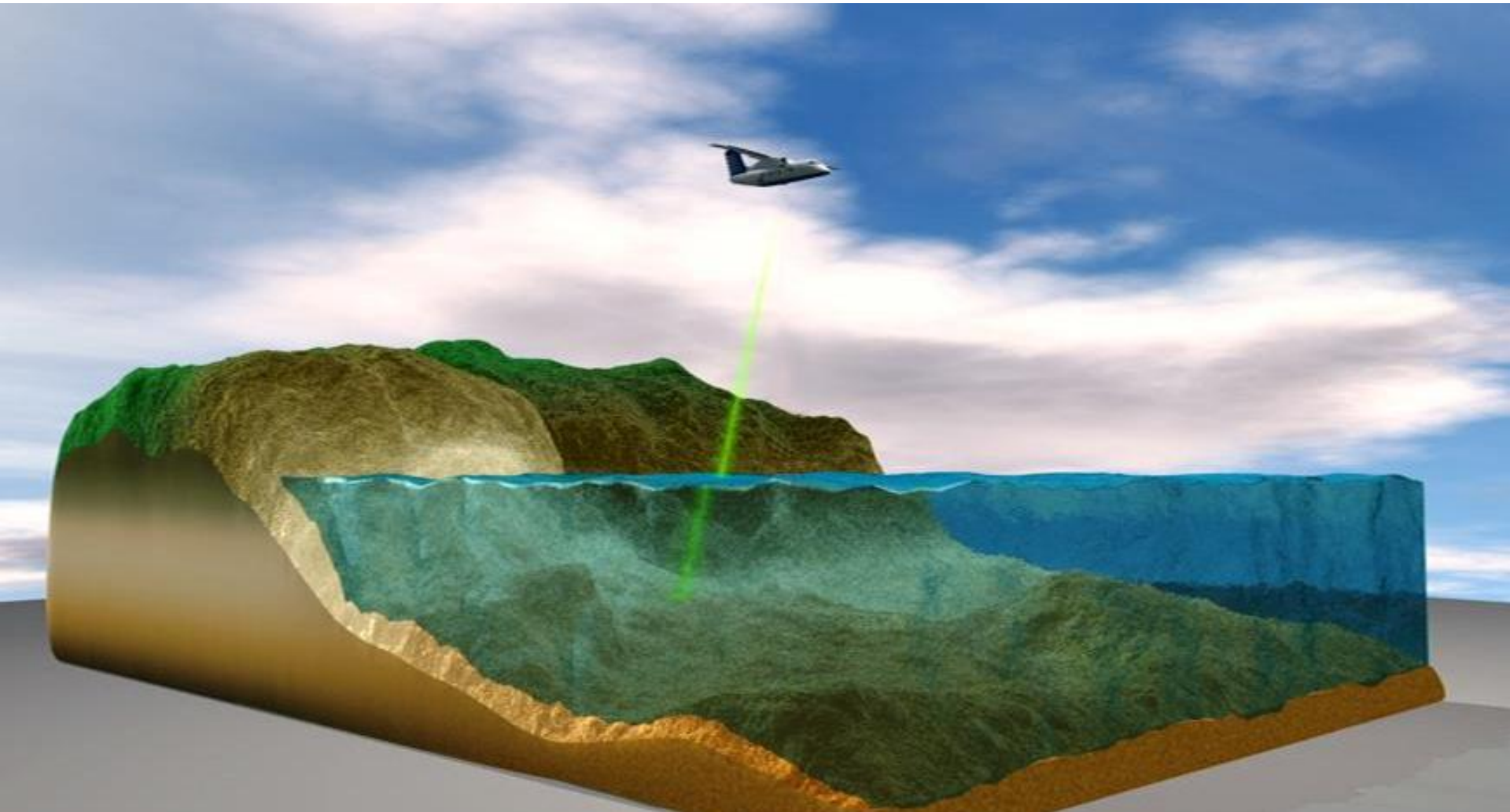
- Acoustic (MBES/SBES/SSS/SBP) Surveys
- Airborne LiDAR Bathymetry (ALB) Surveys
- Capable of multi-sensor operations
- Inclusive of MetOcean and Positioning
- Deliverables include data for nautical charts (SOLAS) and UNCLOS EEZ
- IHO Special Order, 1a, 1b and 2 capable
- Bathymetry, Backscatter/reflectance, water column data

Current / Previous Clients:

- Saudi Arabian General Commission of Survey
- Qatar Ministry of Municipality and Environment
- United Kingdom Hydrographic Office (UKHO / Maritime and Coastguard Authority (MCA)
- SHOM (French Hydrographic Service)
- NOAA (USA)
- Canadian Hydrographic Service
- Australian Hydrographic Office / Royal Australian Navy
- Land Information New Zealand (LINZ)
- Norwegian Hydrographic Service
- Finnish Transport Authority
- Swedish Hydrographic Service
- Geological Survey of Ireland (GSI)



Airborne LiDAR Bathymetry (ALB)

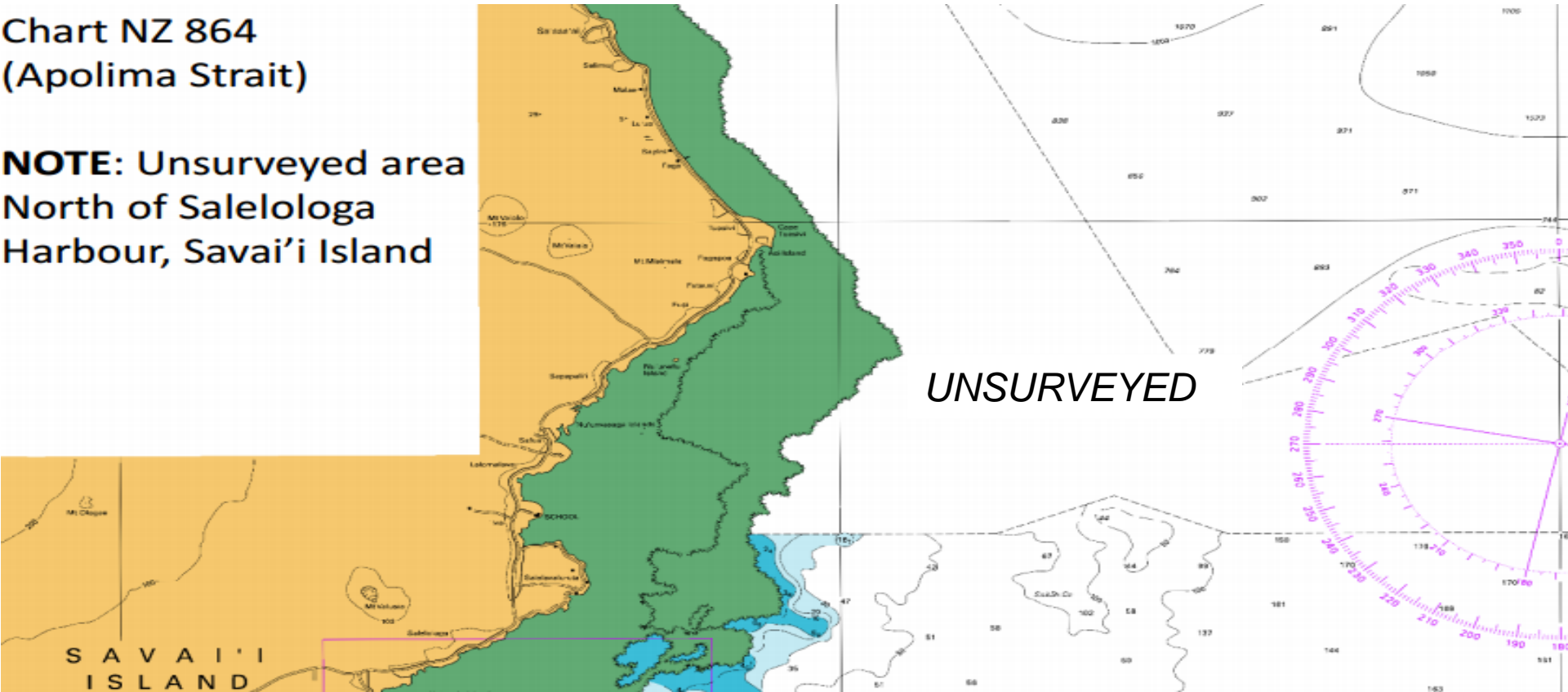


Benefits of ALB



Chart NZ 864 (Apolima Strait)

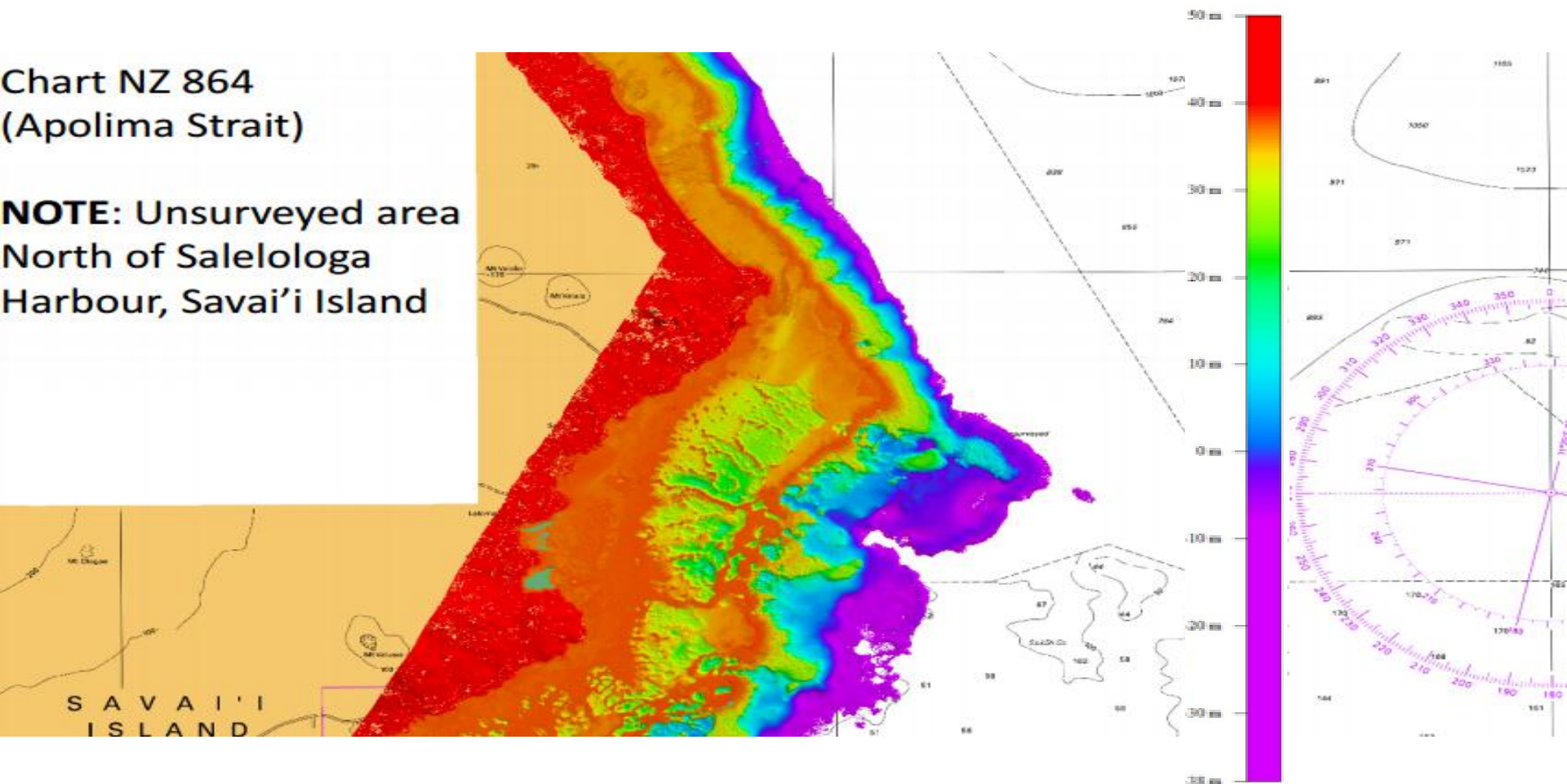
NOTE: Unsurveyed area
North of Salelologa
Harbour, Savai'i Island



Benefits of ALB

Chart NZ 864 (Apolima Strait)

NOTE: Unsurveyed area
North of Salelologa
Harbour, Savai'i Island



Background and overview of sensors

There are now 2 types of ALB systems in production/operation:

1. Traditional Bathymetric LiDAR Sensors with High Power / Lower PRF

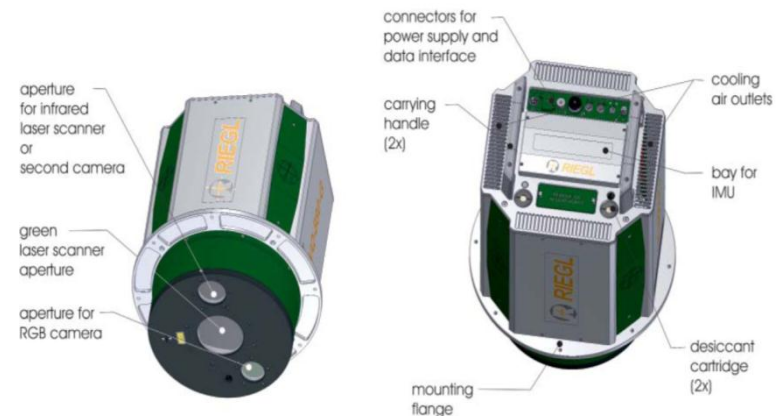
Examples: Fugro LADS HD (Mk 3 / Mk 2 / Mk 1)
 Teledyne Optech CZMIL Nova (deep channel), SHOALS
 Leica Hawkeye III (HE II / HE I)



Fugro's "LADS HD" High Powered ALB system

2. Topo / Bathy Sensors (for shallow Water) with Low Power / Higher PRF

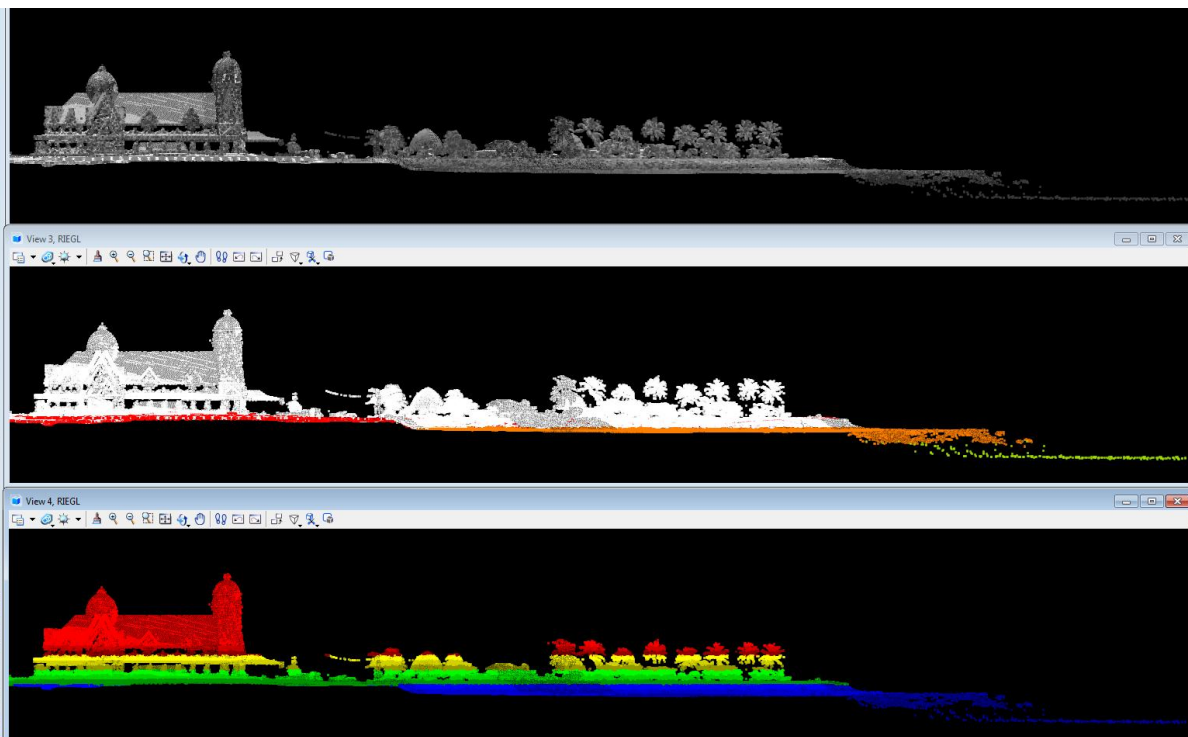
Examples: Leica Chiroptera II
 Riegl VQ-820-G
 Riegl VQ-880-G
 Teledyne CZMIL Nova (shallow channel)
 USGS EAARL-B



Riegl "VQ-880-G" Low Powered ALB System

*Reference: Quadros, N., 2013, LiDAR Magazine • Vol. 3 No. 6,
 "Unlocking the Characteristics of Bathymetric LiDAR Sensors"*

Background and overview of sensors



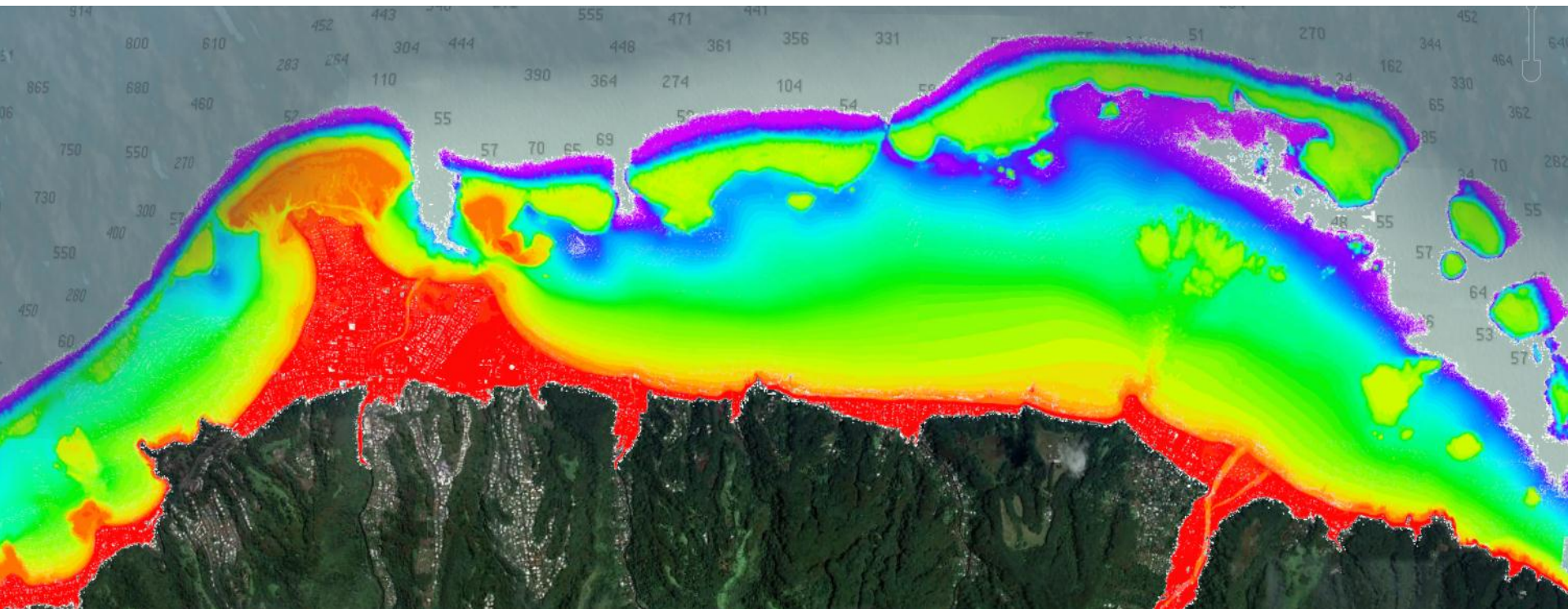
Topo/Bathy (Shallow Water) ALB Sensors

1. Pros:

High Frequency/High resolution/small footprint, smaller units for installation

2. Cons:

Lower power, Limited depth performance, 1 – 1.5 x Secchi Depth



Traditional Bathymetric LiDAR Sensors

1. Pros:

High power, Greater depth performance, 2 – 3 x Secchi Depth

2. Cons:

Low Frequency/lower resolution/larger footprint, Larger units for installation

Multi-sensor operations

Common practice is to nowadays undertake ALB surveys using both type of sensors, for example:

1. FUGRO LADS HD

- 7mj Laser Power
 - Depth performance to 80m in best conditions (3 x Secchi disk)
- High Data Quality
 - Wide Aperture Receiver
 - Automatic Gain Control - for optimised signal return
- Efficient data collection
 - Operating heights from 1200 – 3000 feet
 - 2x2 to 3.5x3.5 m spot spacing;
 - Roll and off-track compensation

2. RIEGL VQ-820-G

- High spatial resolution
 - Up to ~8 points / m²
- Depth performance to 10-15m in best conditions – Very Clear Water (1 x Secchi disk)

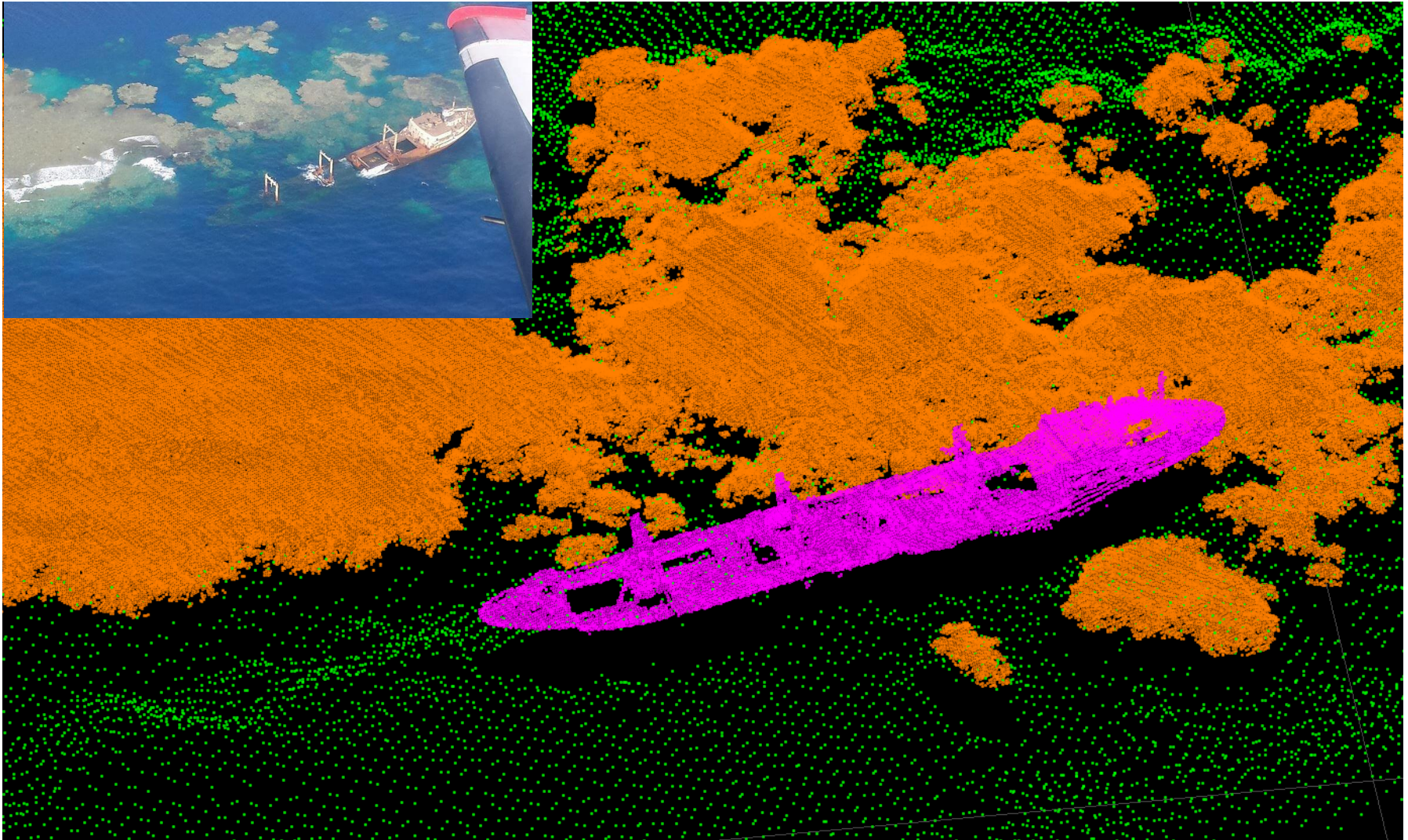




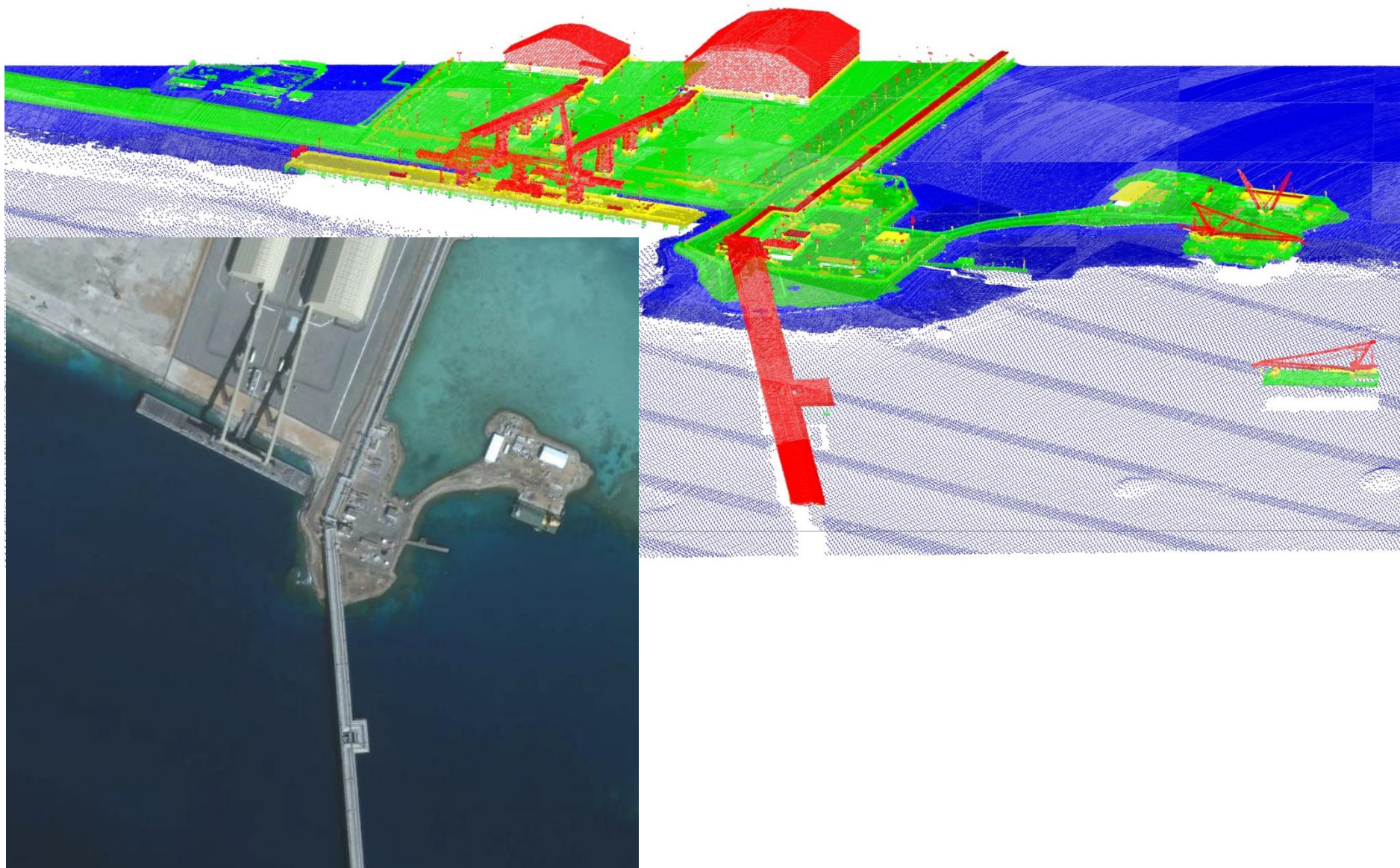
Example of FUGRO LADS + Rieggl data



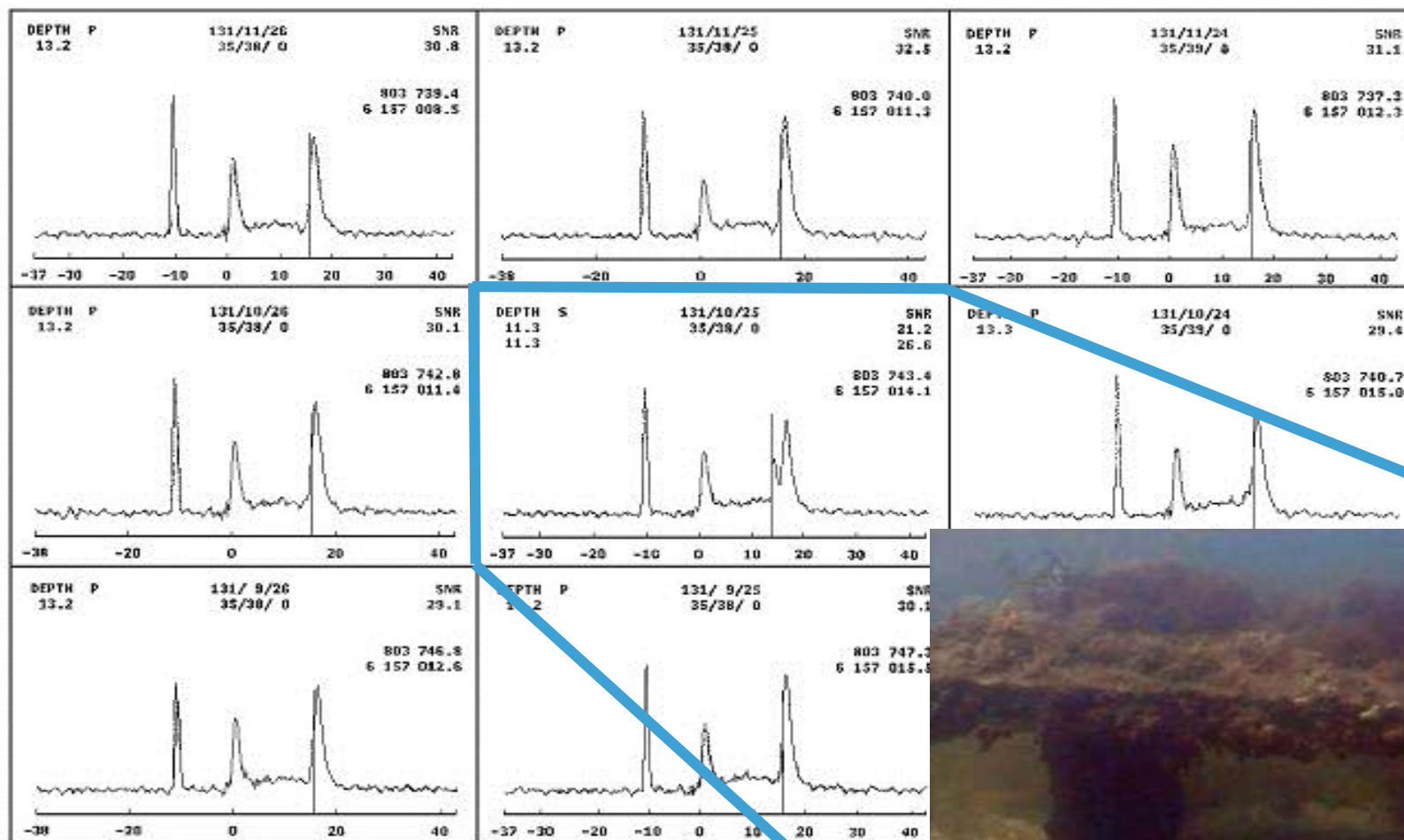
Example of FUGRO LADS + Rieggl data



Example of FUGRO LADS + Riegl data

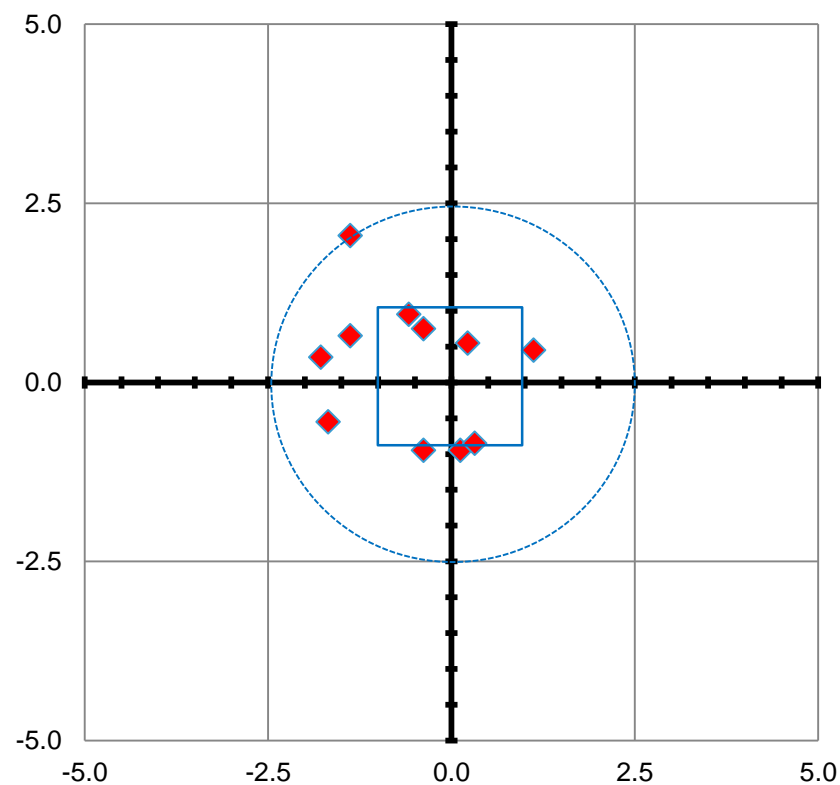
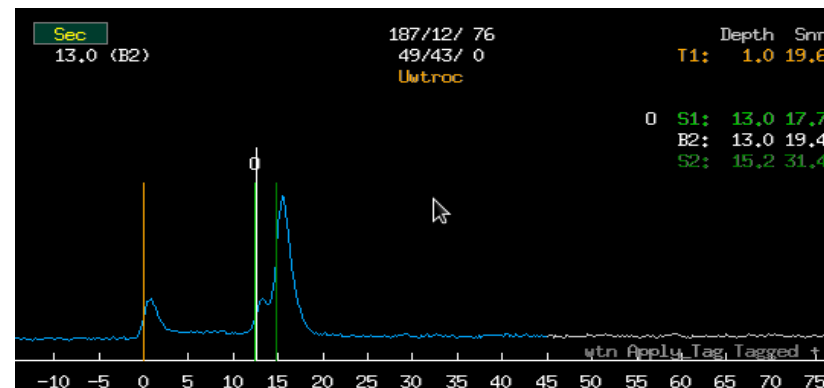


Results from trials – Target detection

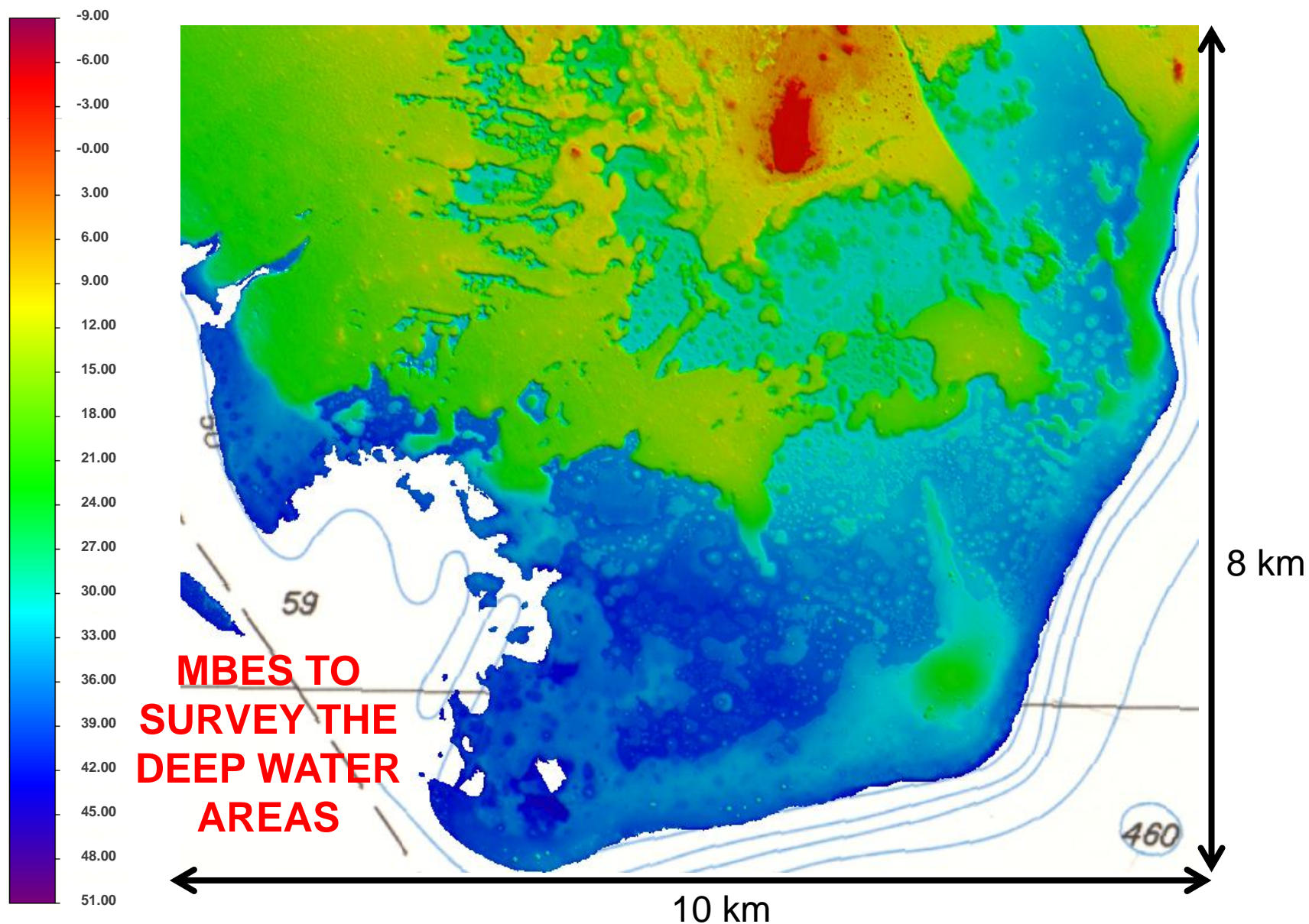


Results from trials – Target detection

	Easting	Northing	ΔE	ΔN
Absolute Position	423728.82	2857523.75		
Line 1	423728.6	2857523.2	0.22	0.55
Line 2	423727.7	2857523.3	1.12	0.45
Line 3	423730.5	2857524.3	-1.68	-0.55
Line 4	423730.6	2857523.4	-1.78	0.35
Line 5	423730.2	2857523.1	-1.38	0.65
Line 6	423728.7	2857524.7	0.12	-0.95
Line 7	423729.4	2857522.8	-0.58	0.95
Line 8	423730.2	2857521.7	-1.38	2.05
Line 9	423728.5	2857524.6	0.32	-0.85
Line 10	423729.2	2857523	-0.38	0.75
Line 11	423729.2	2857524.7	-0.38	-0.95
Mean			-0.53	0.22
Std. Dev.			0.94	0.95



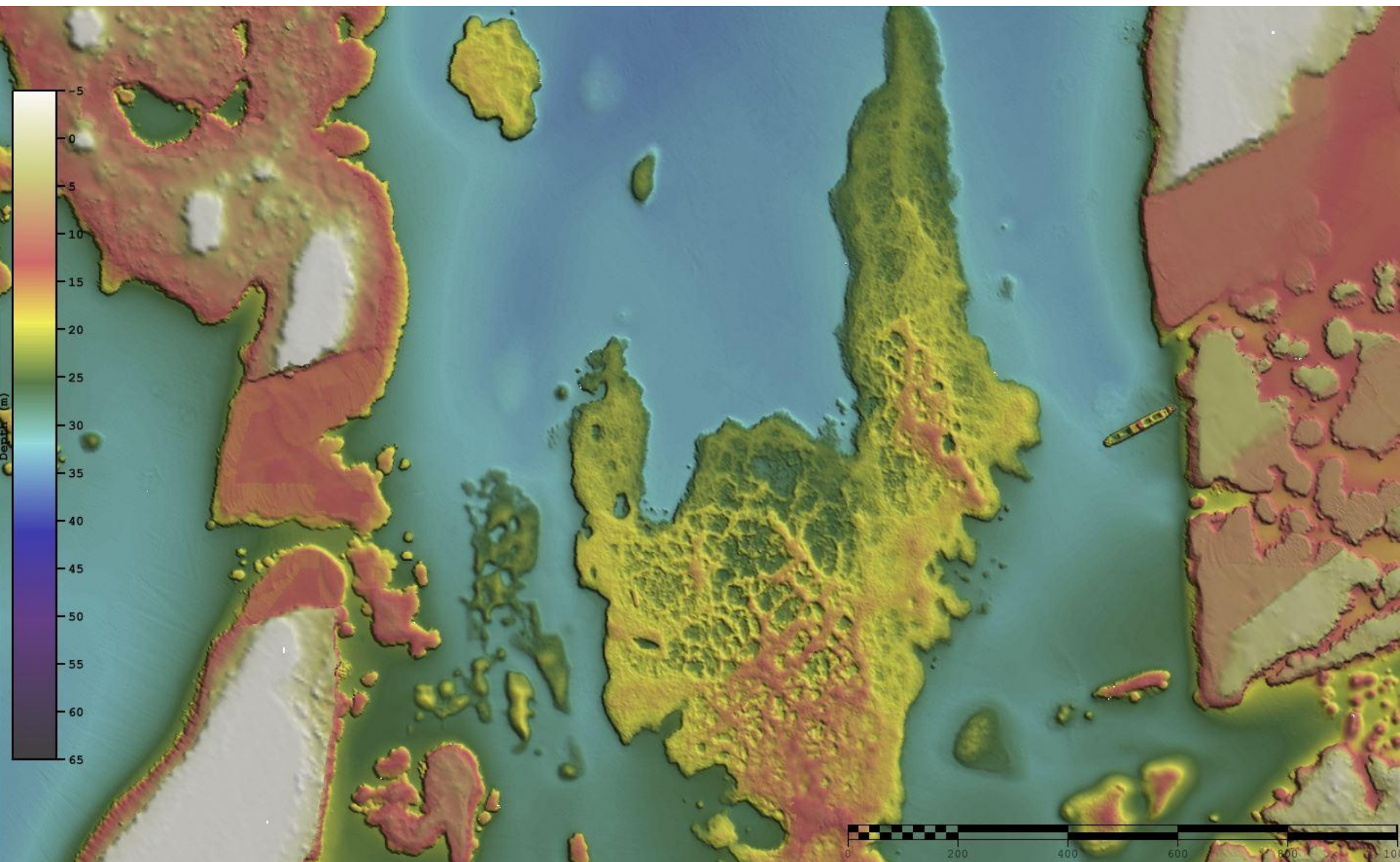
Example of FUGRO LADS + Riegl data



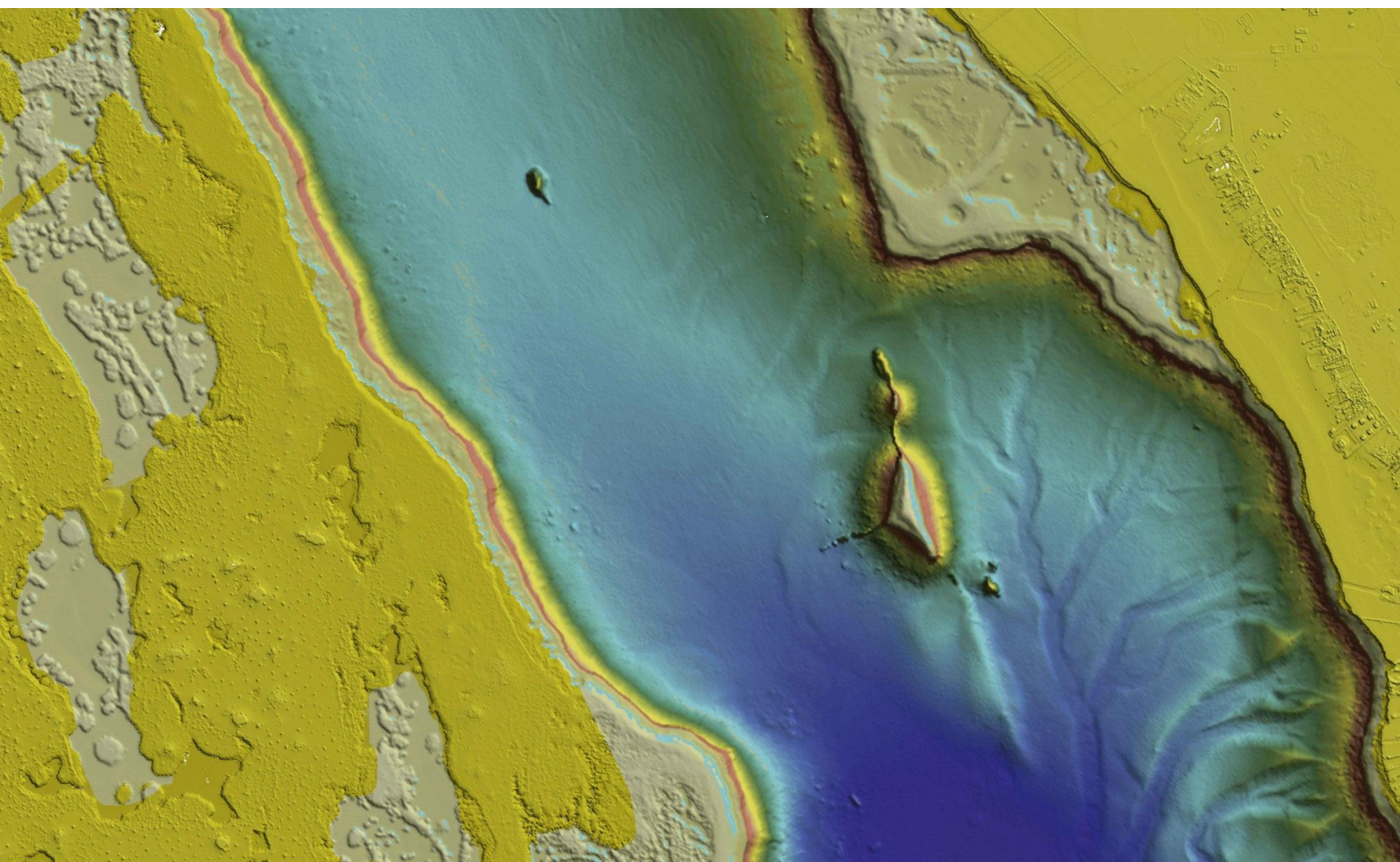
MBES / Vessel Capability (Full Ocean Capable, Multi Role Fleet)



Example of ALB + MBES Data (Merged)



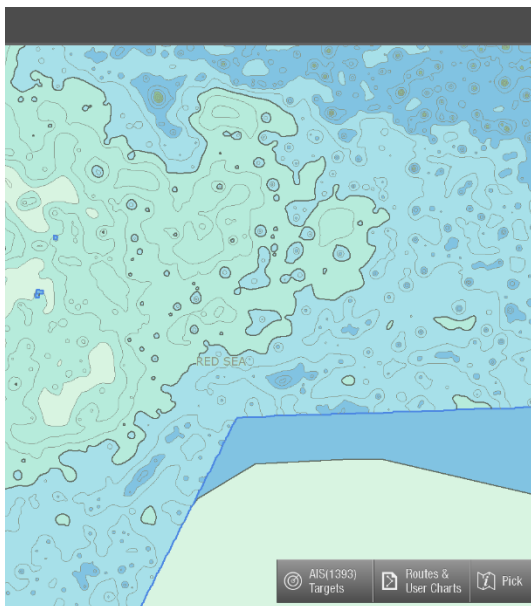
Example of ALB + MBES Data (Merged)



Constant innovation for deliver an unique product

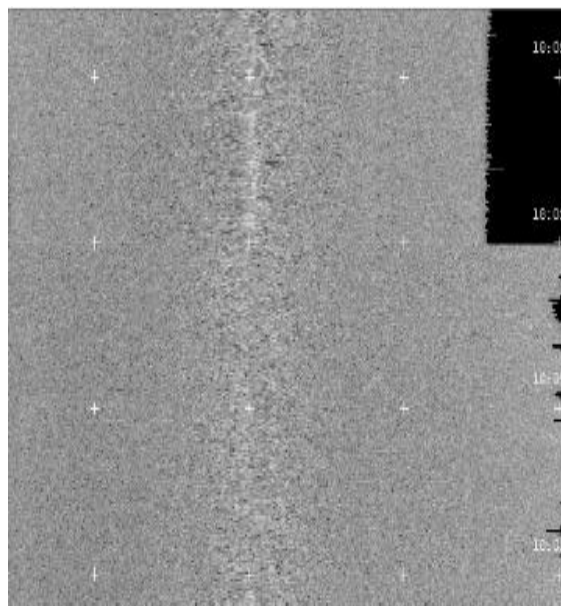
We can support in delivering the final product: Navigable charts.

= NAVIGATIONAL CHARTS



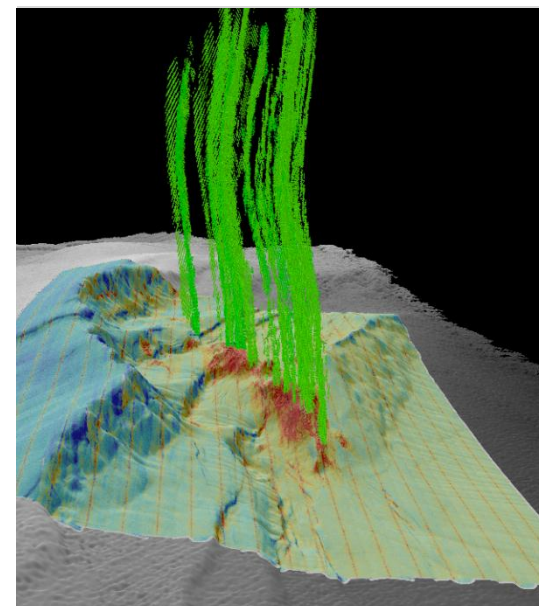
In addition to properly calibrating a MBES for bathymetry, sector-normalized backscatter has been shown to offer superior quality backscatter imagery required for detecting small features on the seafloor.

= CALIBRATED BACKSCATTER



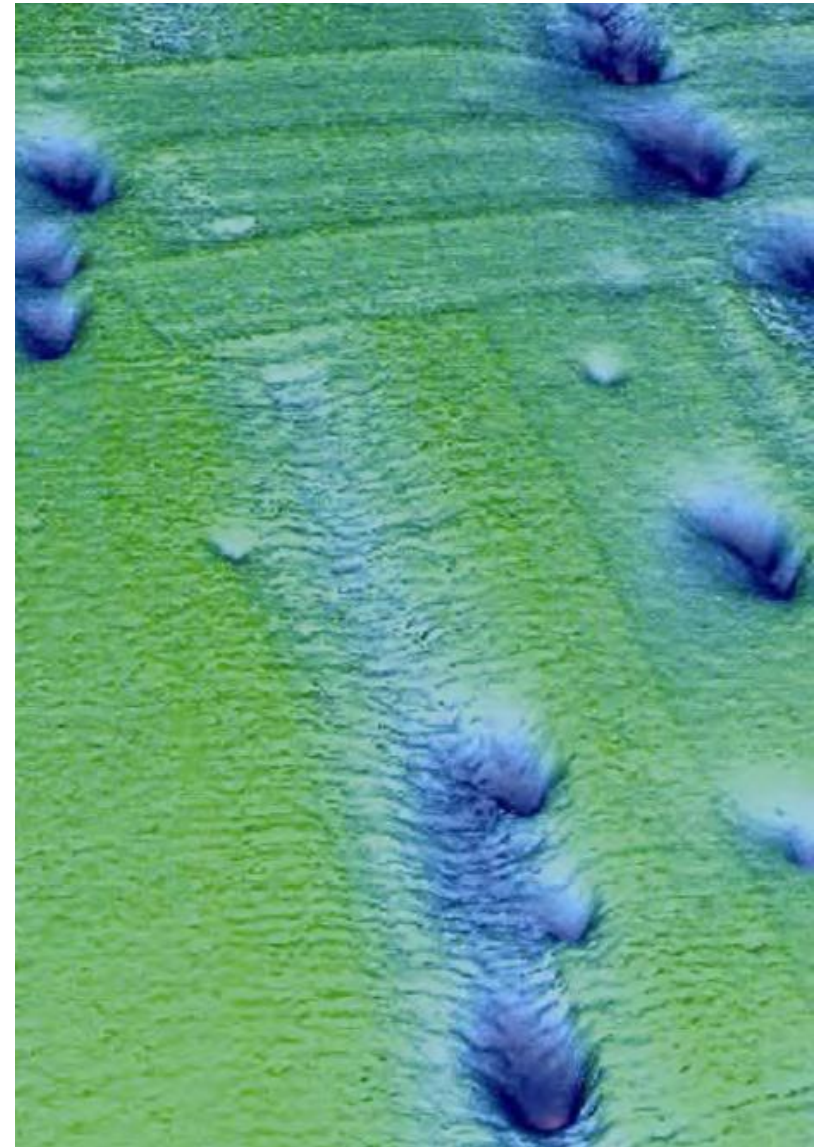
4D data integration and interpretation (bathymetry, backscatter, water column dataset).

- SEEP HUNTING CAMPAIGN



Constant innovation for deliver an unique product

- Fugro's success relies in part on a corporate philosophy to keep moving forward and to be innovative
- The company has grown with their target markets but as the world's economy evolves, so must Fugro in the diversification of its client stakeholder group
- Recent achievements in bringing new technologies to a wider audience (including this one) include:
 - Starfix Global Positioning Services
 - Seawatch
 - Office-Assisted Remote Services (OARS) / Back-2-Base
 - Remote Ocean Current Imaging System (ROCIS)
 - ROAMES Subsea Management Solution





Thankyou

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Questions?

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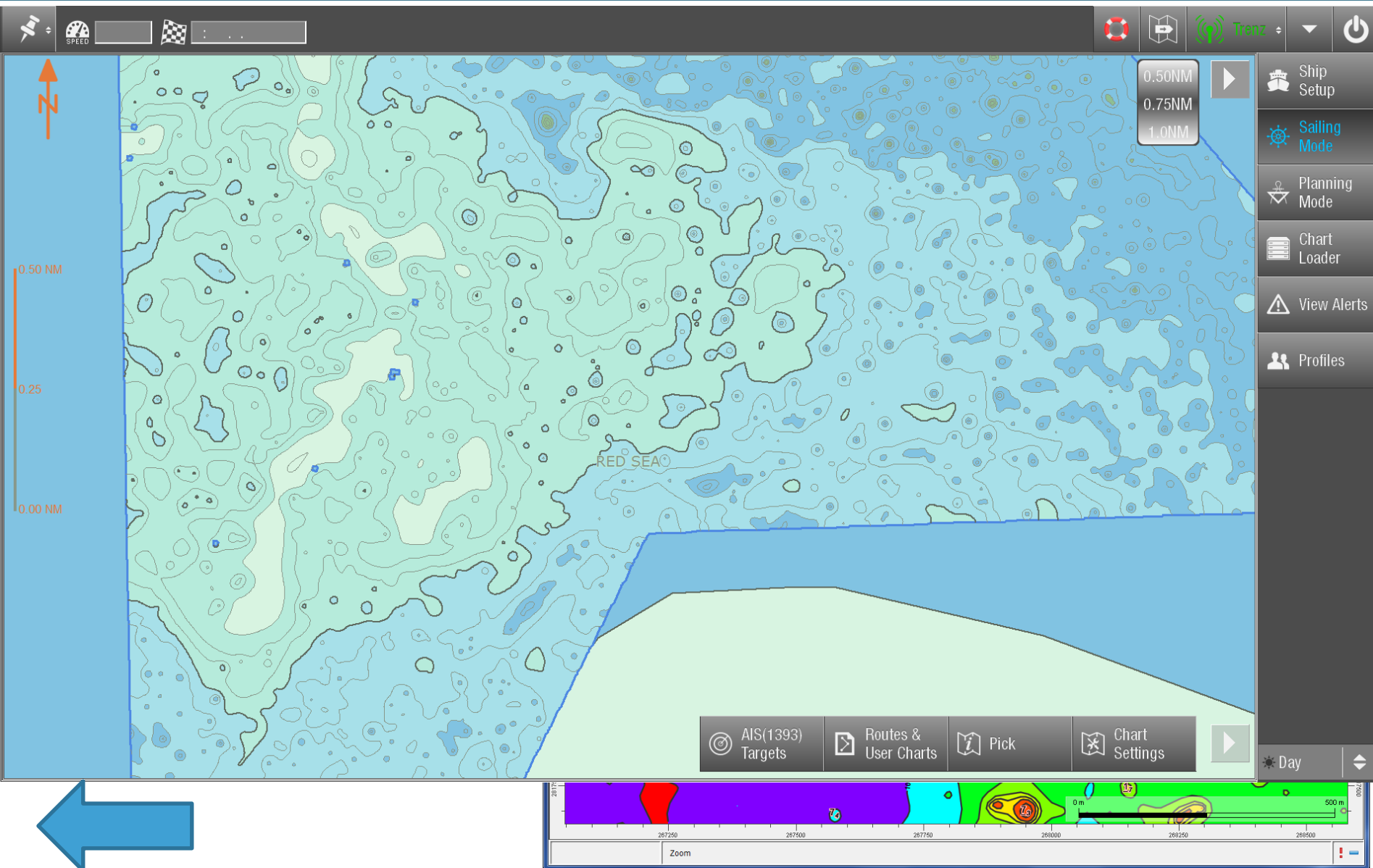
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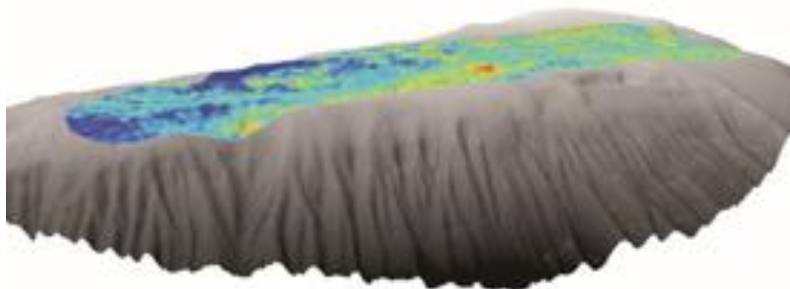
Constant innovation for deliver an unique product



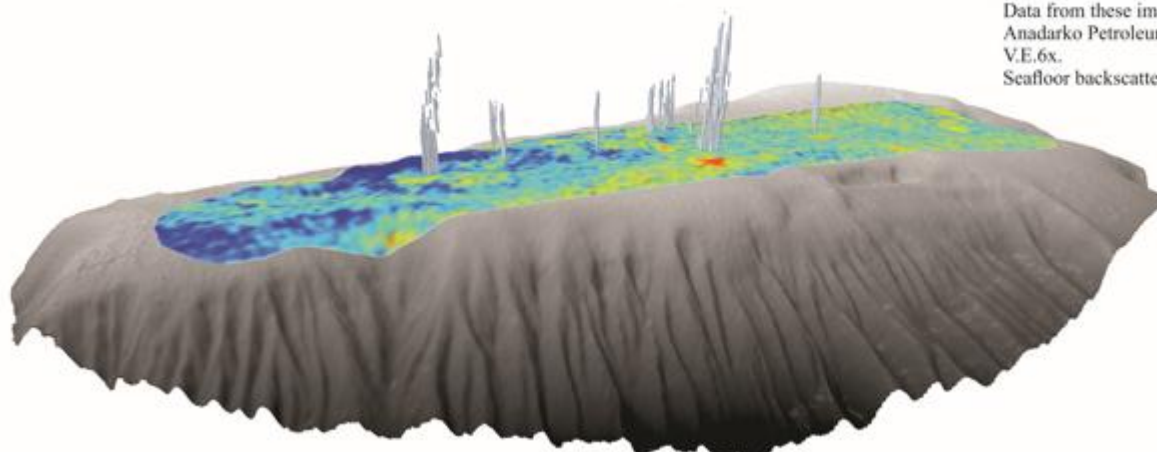


Bathymetry surface from multibeam data

- Backscatter data is superimposed on bathymetry surface



Data from these images courtesy of
Anadarko Petroleum Company.
V.E.6x.
Seafloor backscatter - high = red.



Combined surfaced