Fugro Pelagos, Inc. Expertise and Experience in Hydrographic Surveying with Focus on High Latitudes

Don Ventura

4 December 2013

Company Profile

Fugro provides the **people, equipment, expertise and technology** that support the exploration, development, production and transportation of the world's natural resources.

Client Sectors

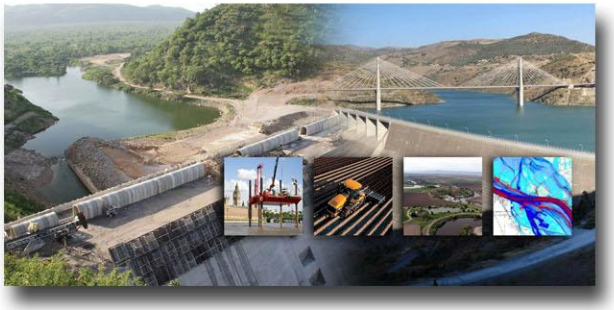
Oil & Gas

Mining

Building and Infrastructure

Sustainable Energy

Public Sector



Other Sectors

We align our service offer with six key **client sectors**, providing support and resources tailored to the specific needs of each. This enables us to deliver multi-disciplined, cross-divisional solutions anywhere in the world.

Resources

11,500 Employees

49 Vessels

75 CPT Trucks

27 Laboratories

29 Jack-up Platforms

27 Aircraft

261 Land-based Drill Rigs
17 Offshore Drill Rigs

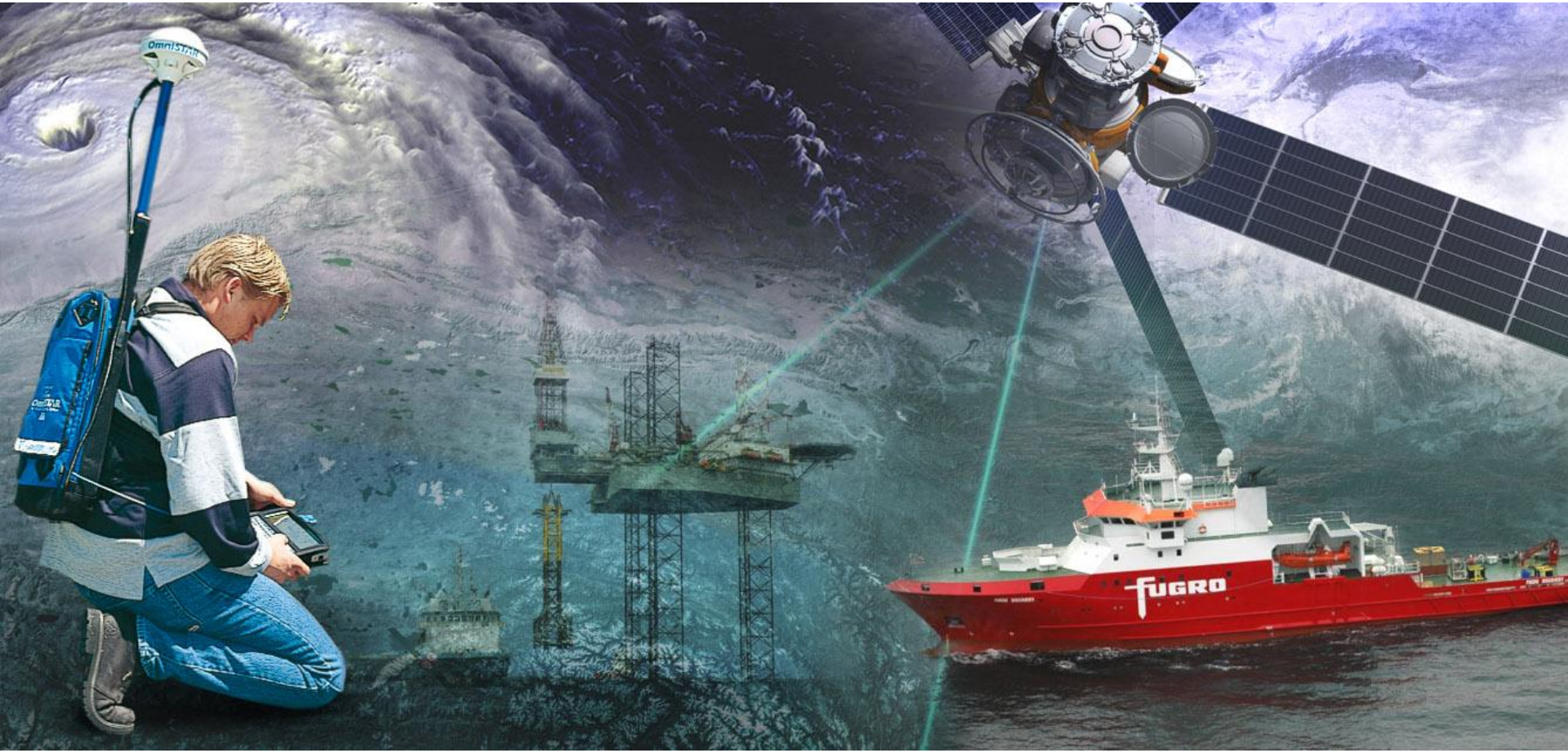
150 ROVs

9 AUVs

250 Offices

Fugro's **people, vessels, equipment** and **facilities** are continually growing in capability and expertise in order to meet the demand for continuous high quality services in ever-more challenging regions of the globe.

Survey Activities

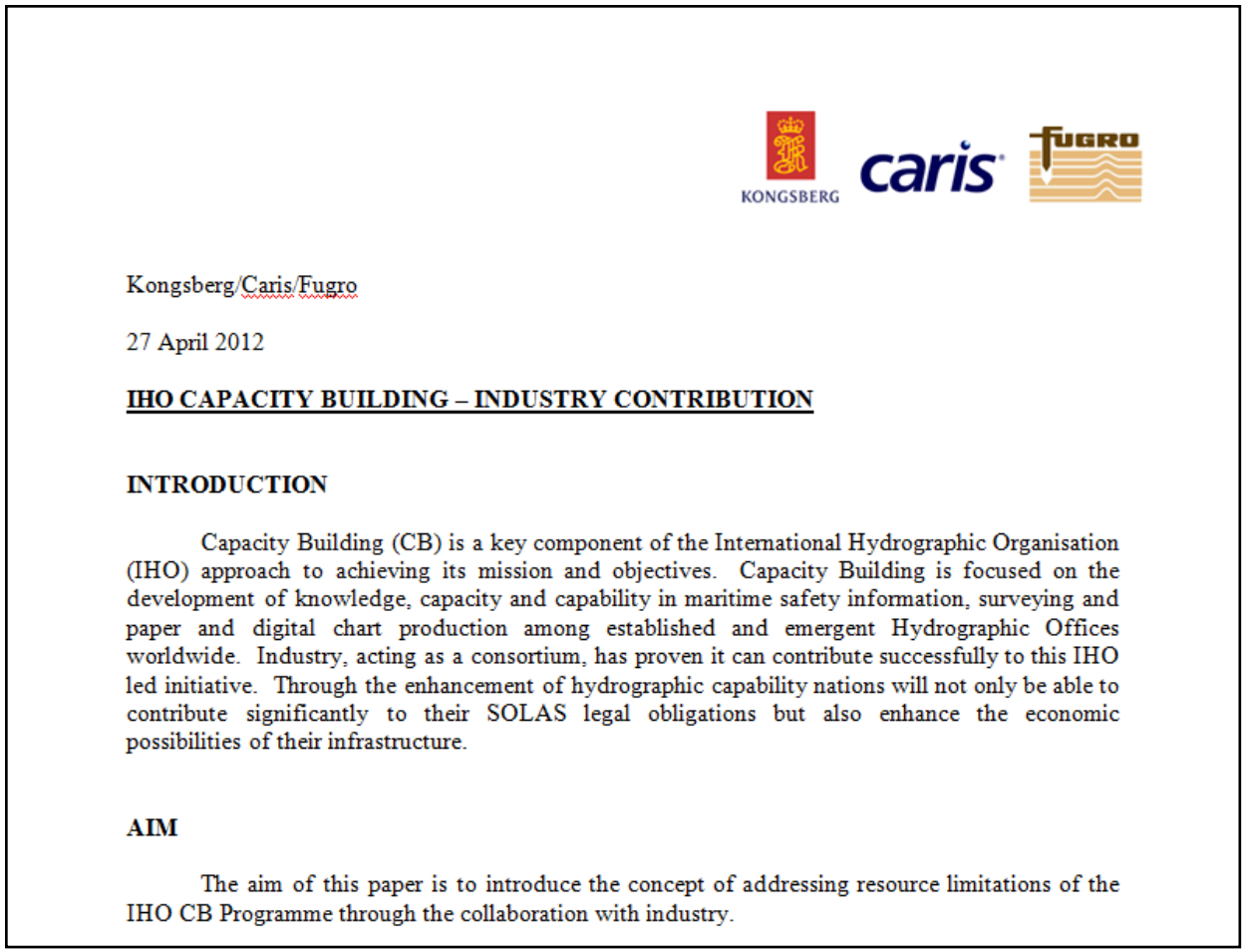


Fugro provides the energy industry, commercial and civil industries, governments and other organisations with numerous offshore, subsea and geospatial activities tailored to the specific needs of each client.

Fugro Pelagos – Company Profile

- Established in 1977
- Offices in San Diego, Ventura, Oakland, CA; Anchorage, AK; Seattle, WA and Stennis, MS
- International experience (>40 countries)
- > 80 professional staff
- Core Competencies:
  - Acoustic and seismic marine survey
  - Airborne and vessel based Lidar survey
  - Cable Route Survey
  - Hardware and Software Engineering
- QHSE Certifications:
  - ISO 9001-2008
  - ISO 14001-2004
  - OSHAS 18001-2007

Recent Industry Participation in IHO CBSC



Kongsberg/Caris/Fugro

27 April 2012

IHO CAPACITY BUILDING – INDUSTRY CONTRIBUTION

INTRODUCTION

Capacity Building (CB) is a key component of the International Hydrographic Organisation (IHO) approach to achieving its mission and objectives. Capacity Building is focused on the development of knowledge, capacity and capability in maritime safety information, surveying and paper and digital chart production among established and emergent Hydrographic Offices worldwide. Industry, acting as a consortium, has proven it can contribute successfully to this IHO led initiative. Through the enhancement of hydrographic capability nations will not only be able to contribute significantly to their SOLAS legal obligations but also enhance the economic possibilities of their infrastructure.

AIM

The aim of this paper is to introduce the concept of addressing resource limitations of the IHO CB Programme through the collaboration with industry.

http://www.iho.int/mtg_docs/com_wg/CBC/CBSC10/CBSC10-15C-White_Paper_-_Industry_Contribution_to_IHO_CB.pdf

Recent Industry Participation in IHO CBSC

KONGSBERG caris FUGRO

Kongsberg/Caris/Fugro

20 May 2013

IHO CAPACITY BUILDING – INDUSTRY CONTRIBUTION - REVIEW AND UPDATE

BACKGROUND

At the IRCC4, held in Singapore 7-8 June 2012, representative companies of the international hydrographic industry submitted a paper suggesting the roles and support which Industry could provide in the fulfillment of the IHO's Capacity Building (CB) initiative. The paper addressed ways to overcome resource limitations in various regions which were (are) over and above the capacity for leading industrial national governments to address. The paper (CBSC 10-15C) can be accessed at:

http://www.iho.int/mtg_docs/com_wg/CBC/CBSC10/CBSC10.htm

Developed to meet the IHO's 3-Phase strategy and within the framework of the 4-step process of Awareness, Assessment, Analysis and Action, Industry suggested solutions in the following key areas necessary for the successful implementation of an enduring CB policy:

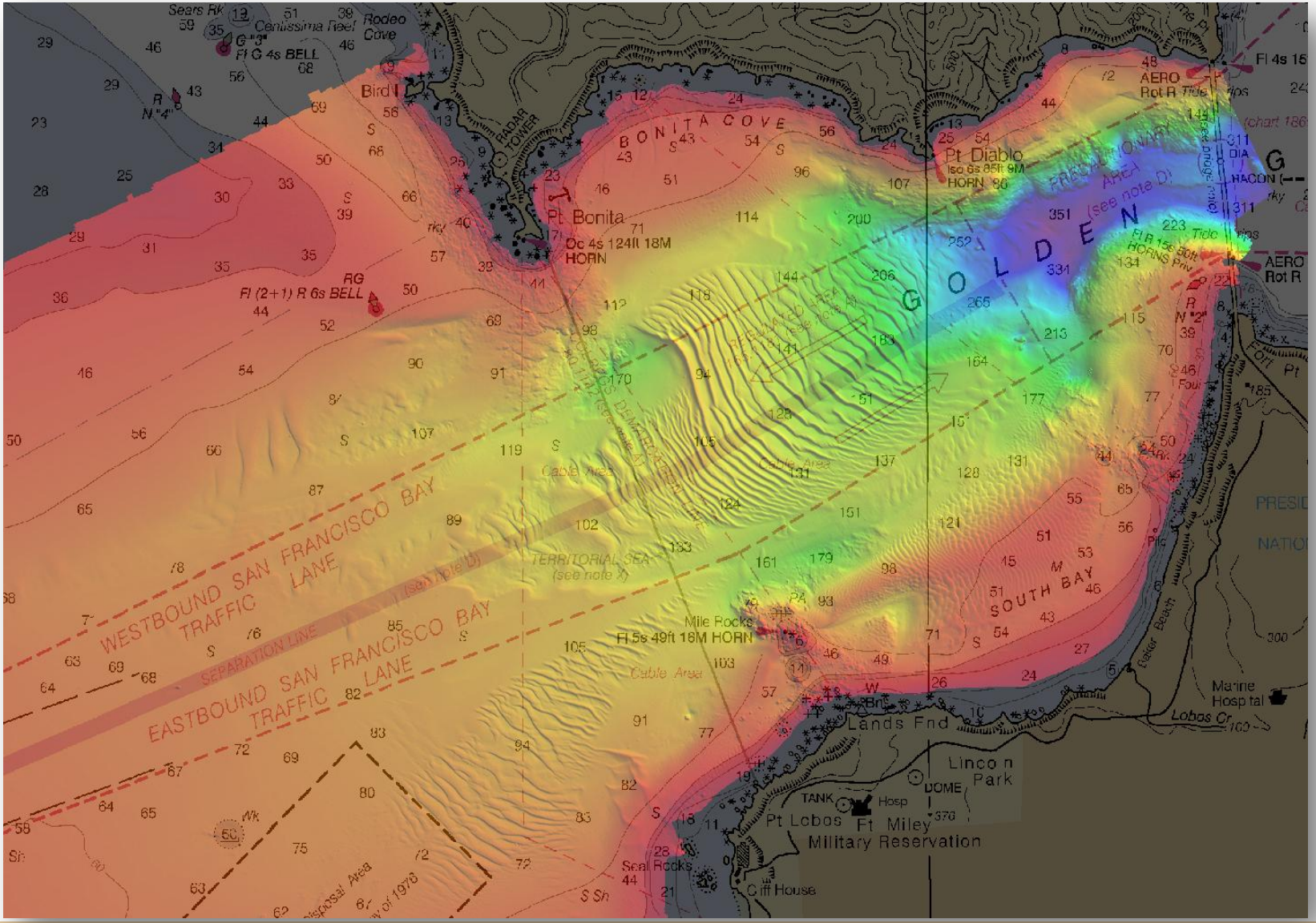
CBSC11-04 (not yet published on the IHO CBSC website)

Fugro and the Hydrographic Academy

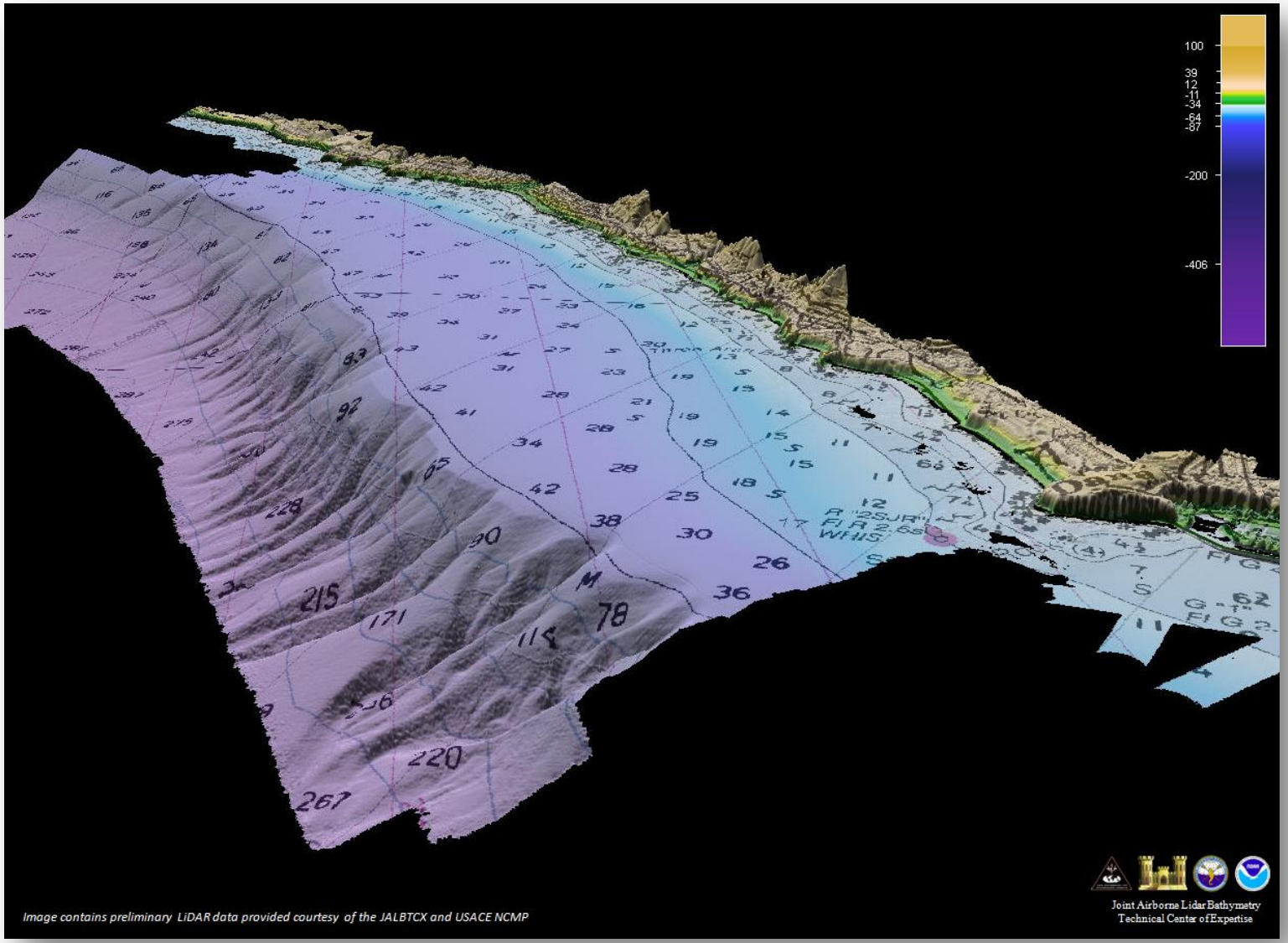
DISTANCE E-LEARNING WITH PLYMOUTH UNIVERSITY
The Hydrographic Academy

- Distance learning hydrographic surveying courses
- Flexible learning that fits around working patterns and location
- University level qualifications and professional body recognition
- Individual CPD modules, undergraduate and postgraduate qualifications

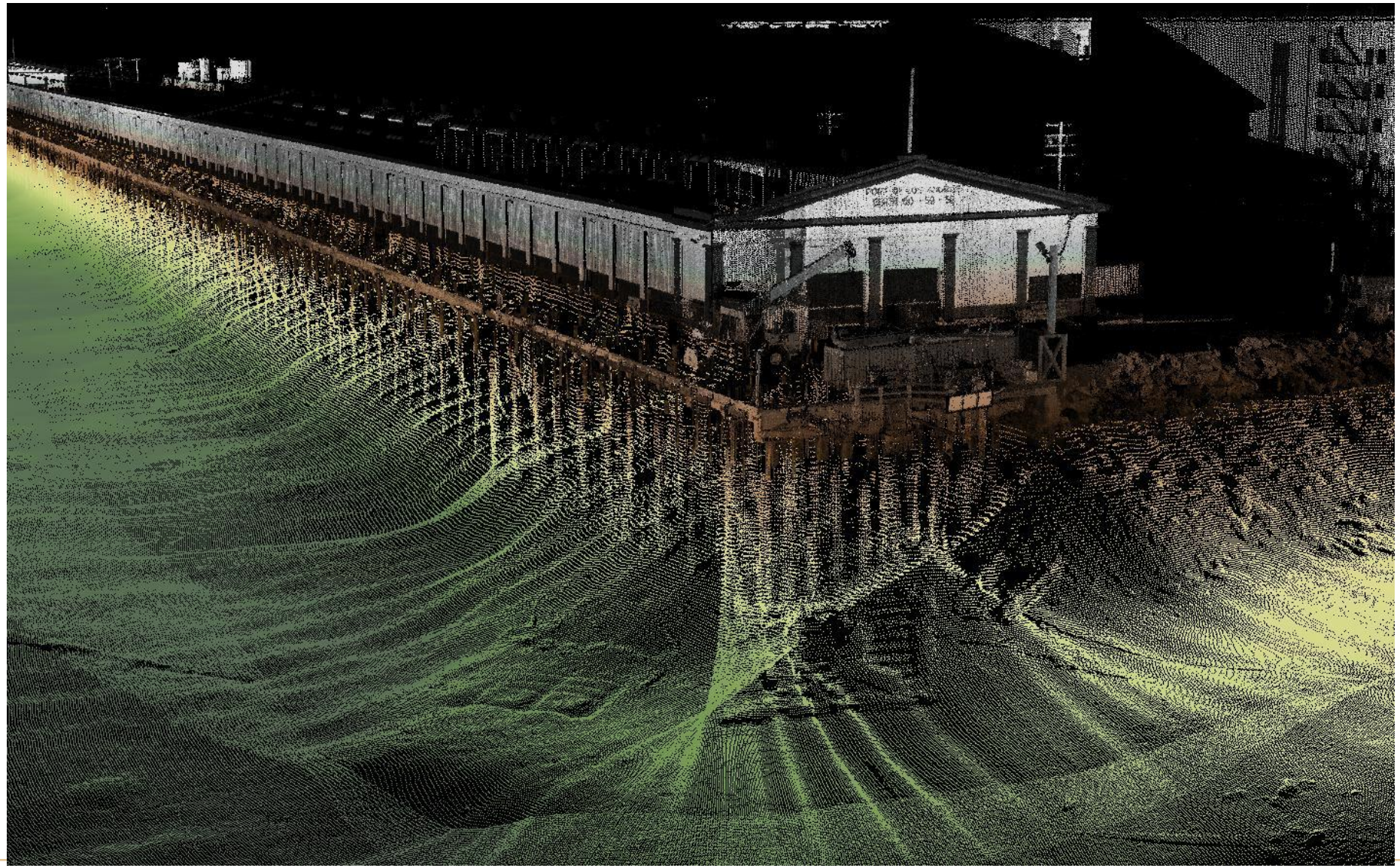
Hydrographic Surveying/Charting – Acoustic



Integration of MBES with Topo and bathy LiDAR delivers seamless dataset

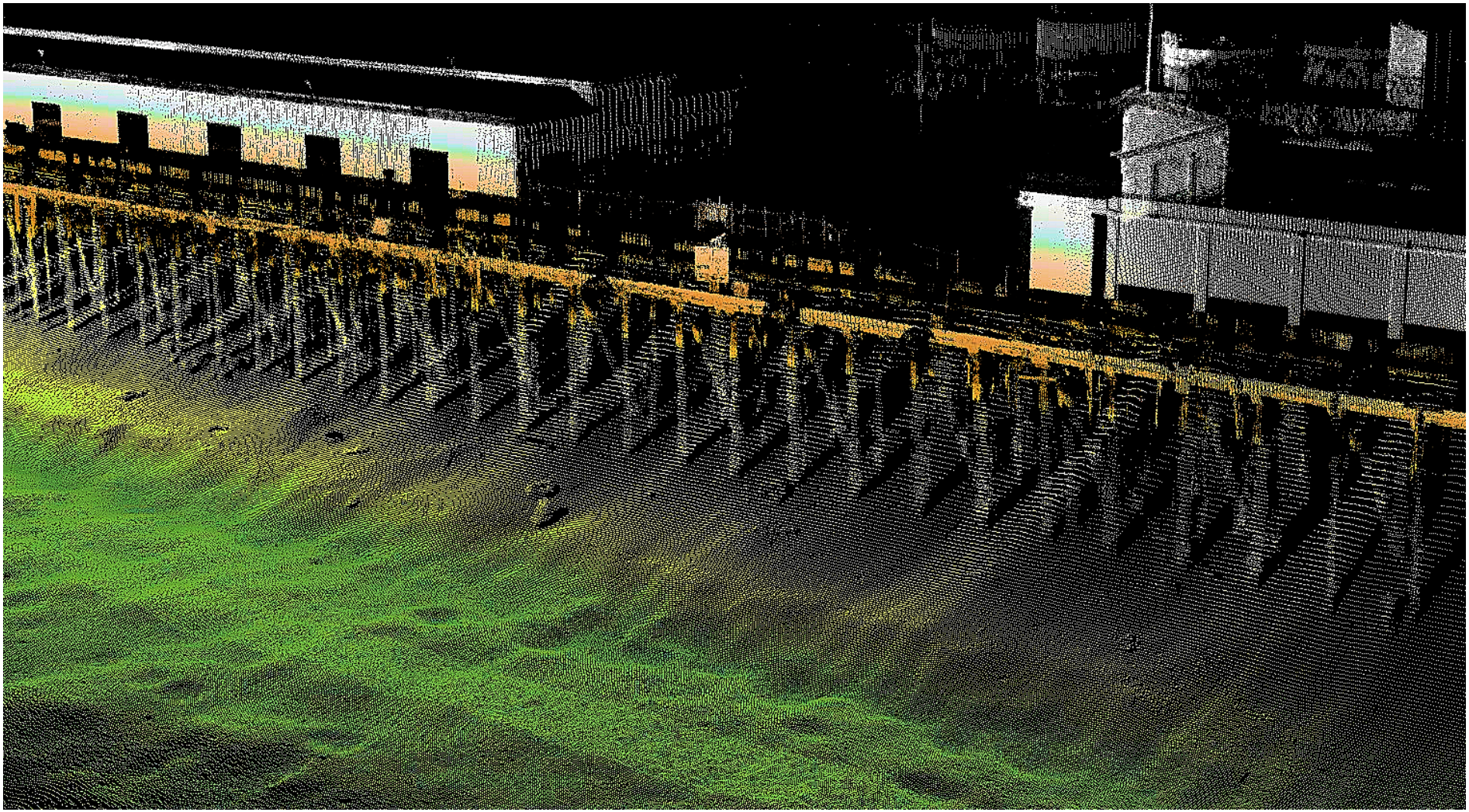


Integrated MBES & LLS (BoatMap®)



Port of Los Angeles

Integrated MBES & LLS (BoatMap®)

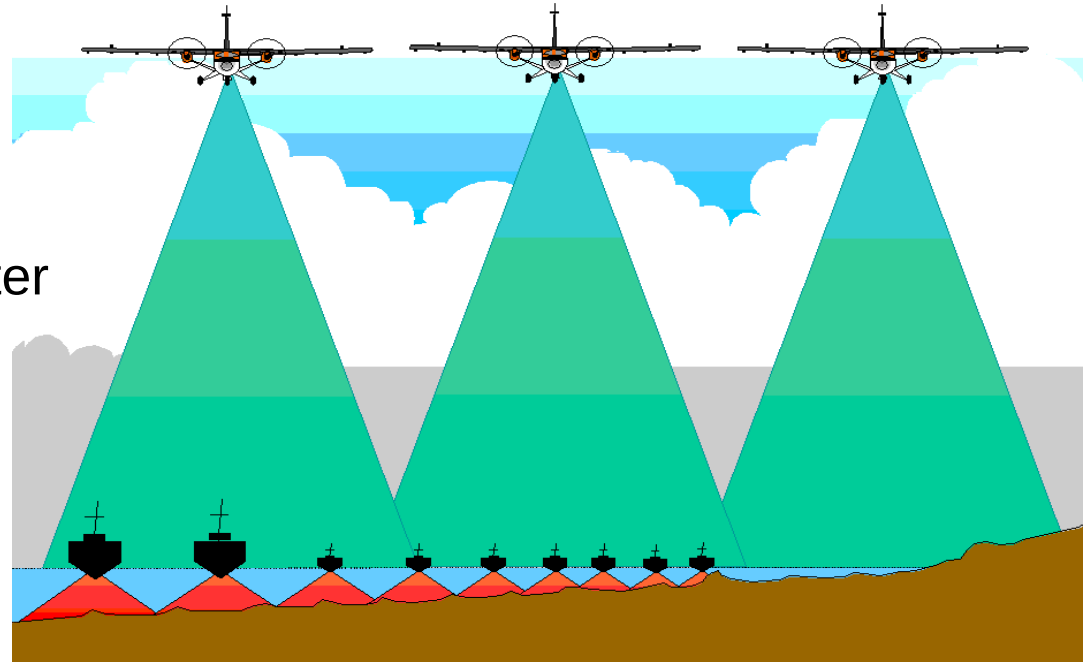


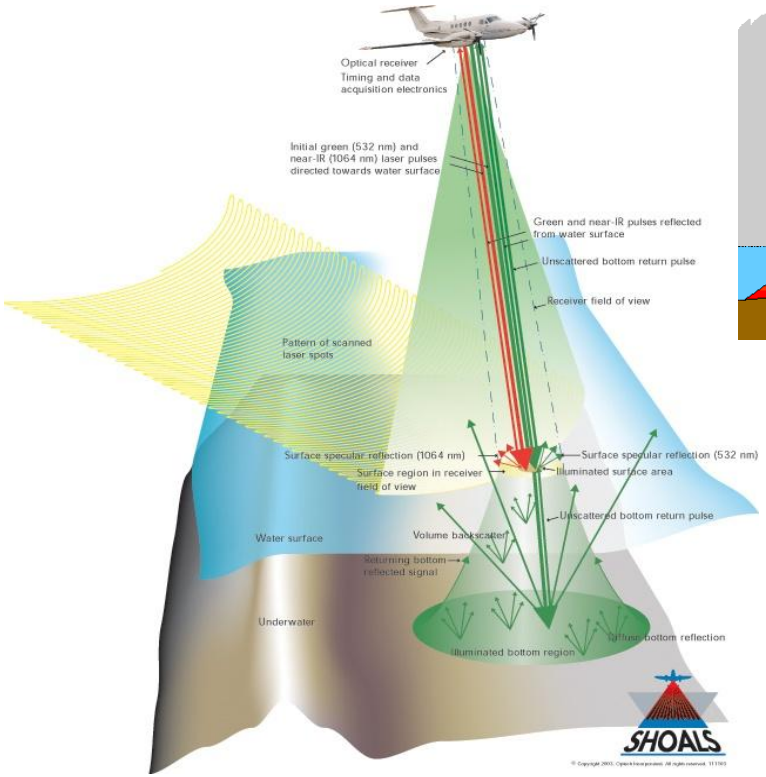
Port of Los Angeles

ALB – General Concept

ALB uses two lasers

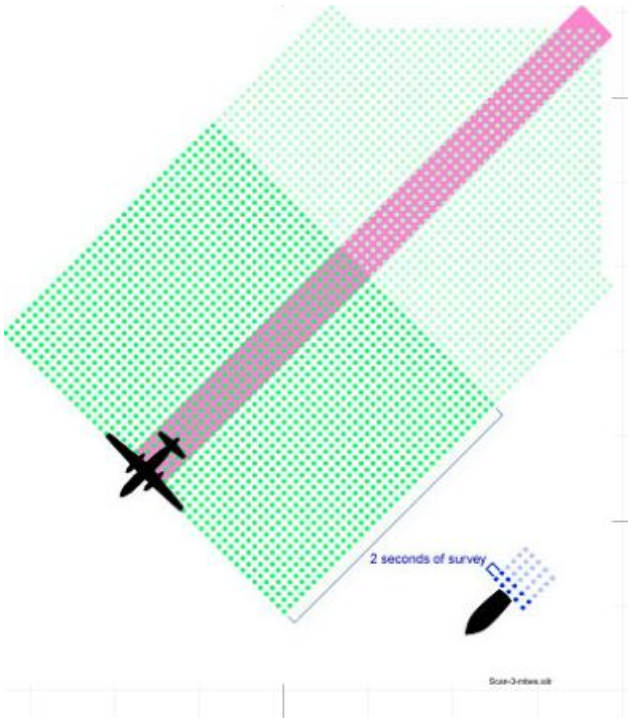
- Infrared to reflect off the water surface
- Green to penetrate the water

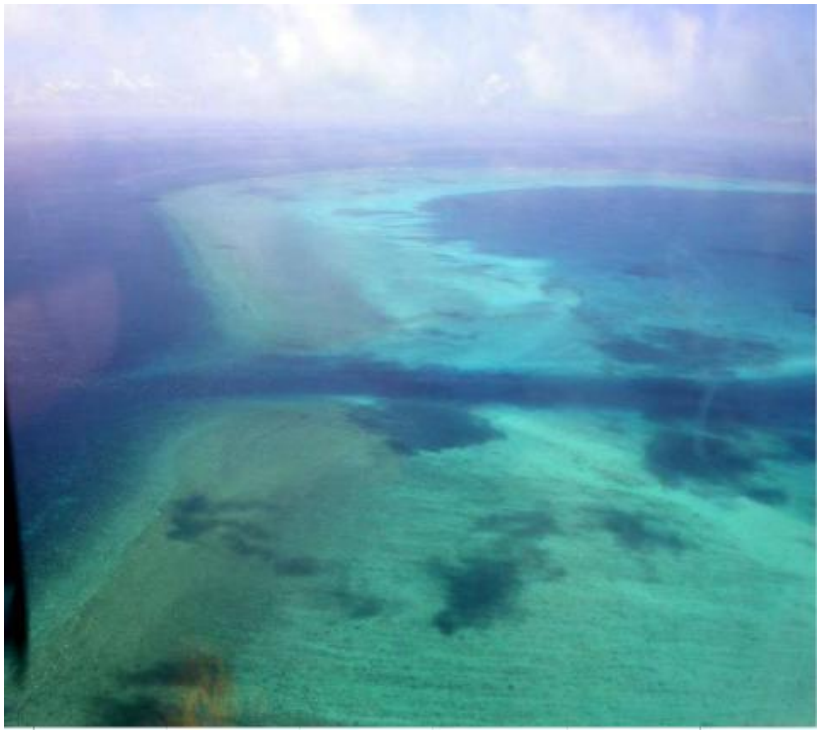




In shallow waters ALB is much more efficient than MBES because of its consistent swath regardless of water depth

Fugro ALB: General Capability

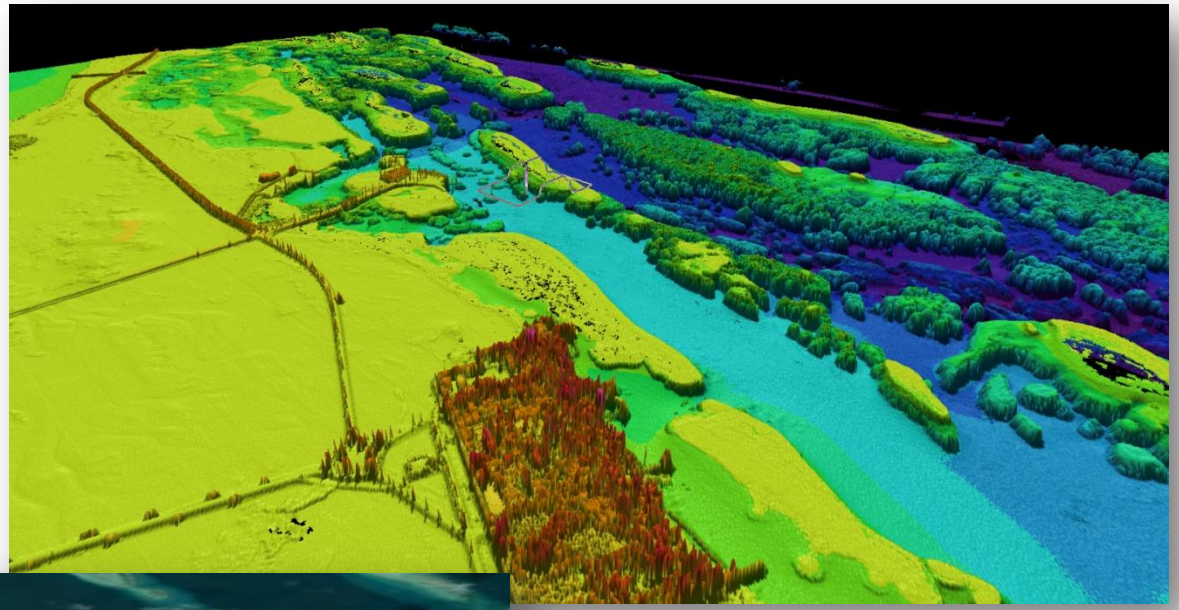




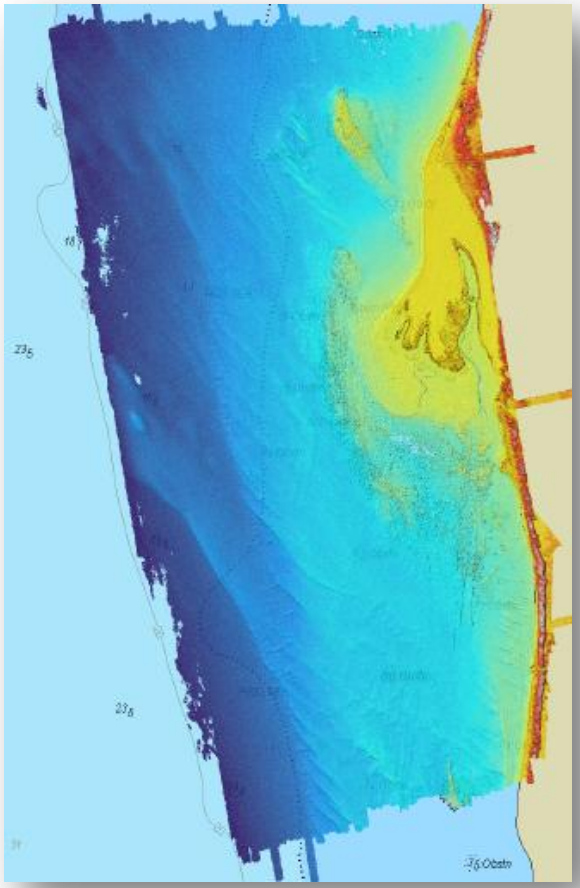
- Coverage rate much faster than boats, to a maximum depth of 50-80m
- Resolution not as high as MBES
- IHO Order 1a or 1b surveys
- In very shallow water only way to effectively survey in a safe and efficient manner
- Needs clear water
- Designed initially for efficient charting of areas such as the Great Barrier Reef

Past Hydrographic LIDAR Experience

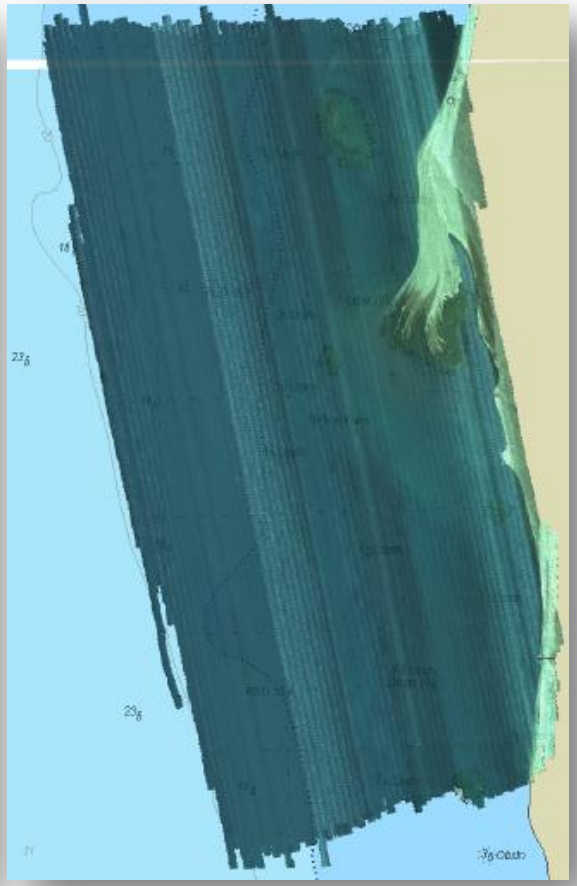
Efficient Coastal Zone Survey with ALB



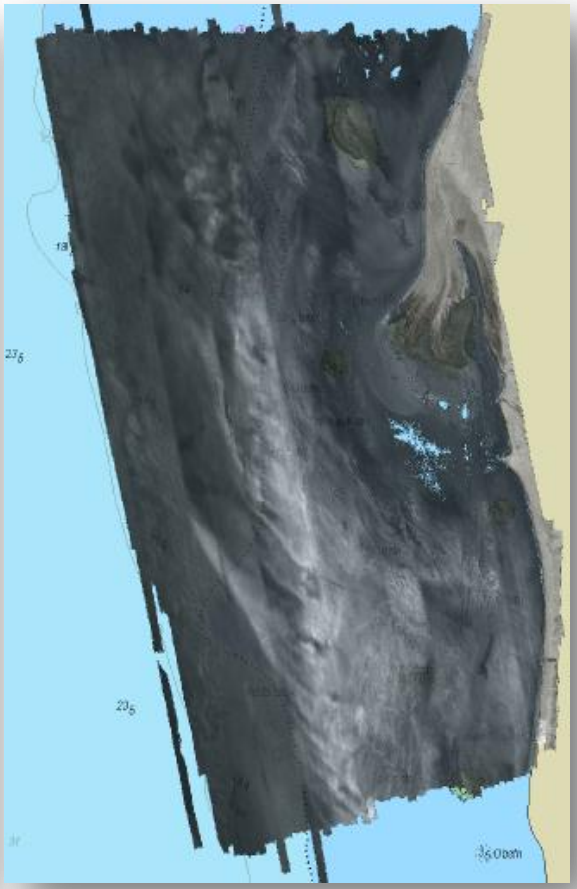
Multiple products from single acquisition



Bathymetry



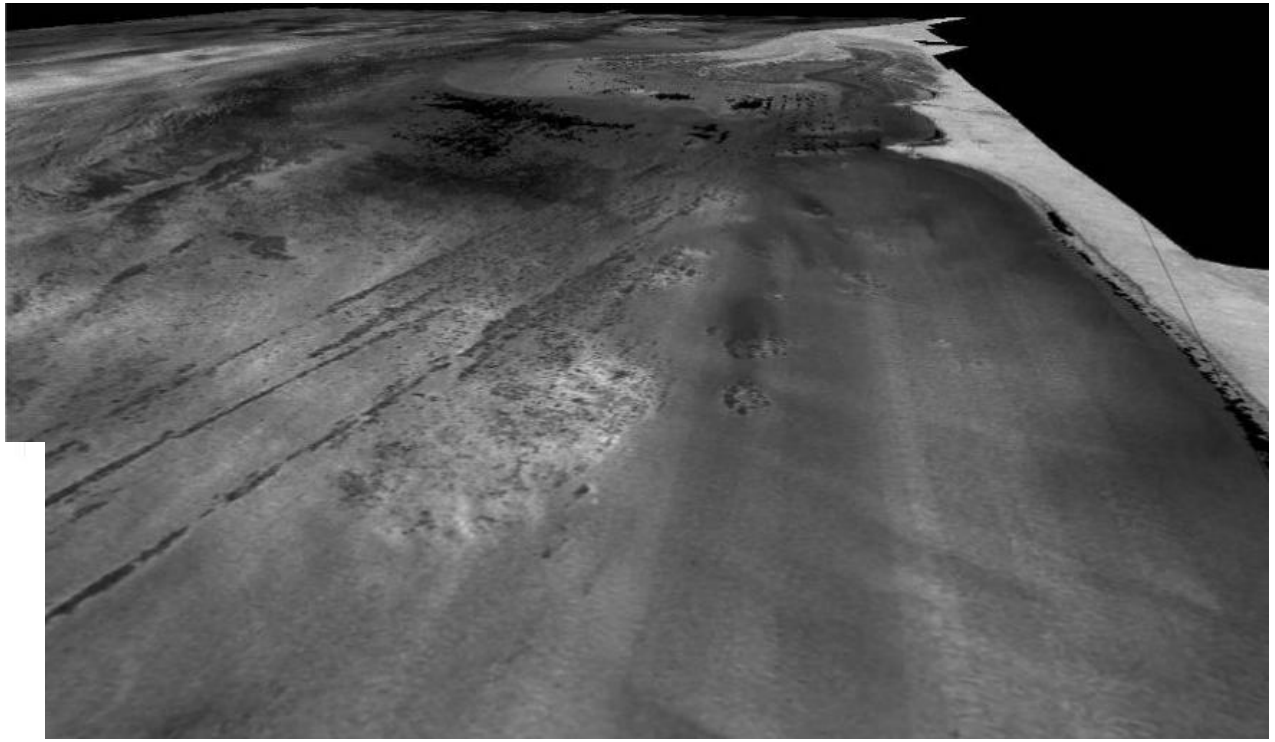
Imagery

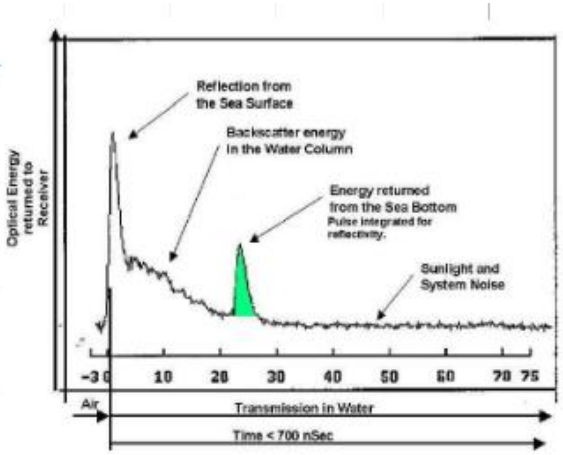


Reflectance

Bathymetric Point Clouds and Surfaces

Additional Datasets – Reflectivity

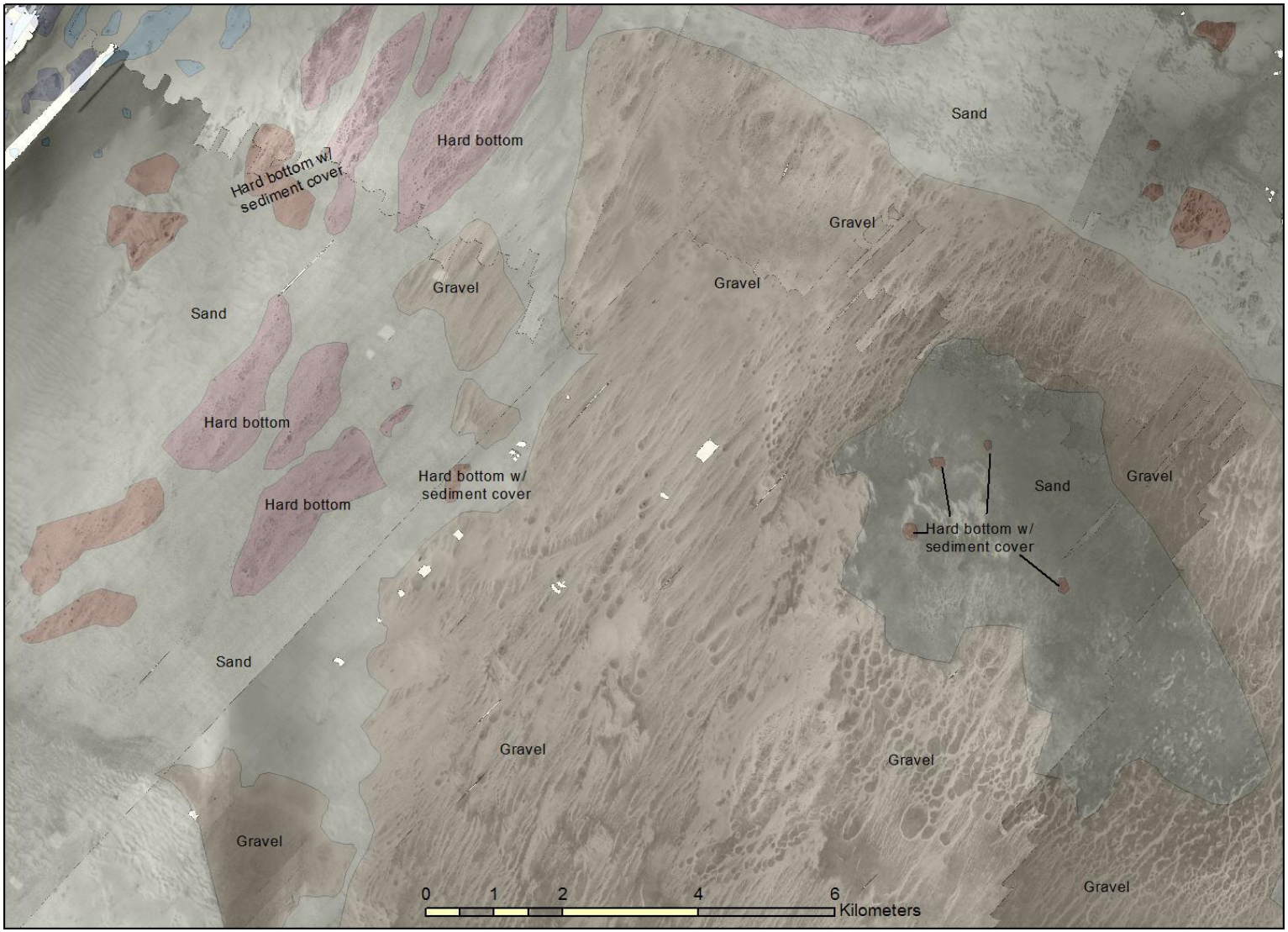




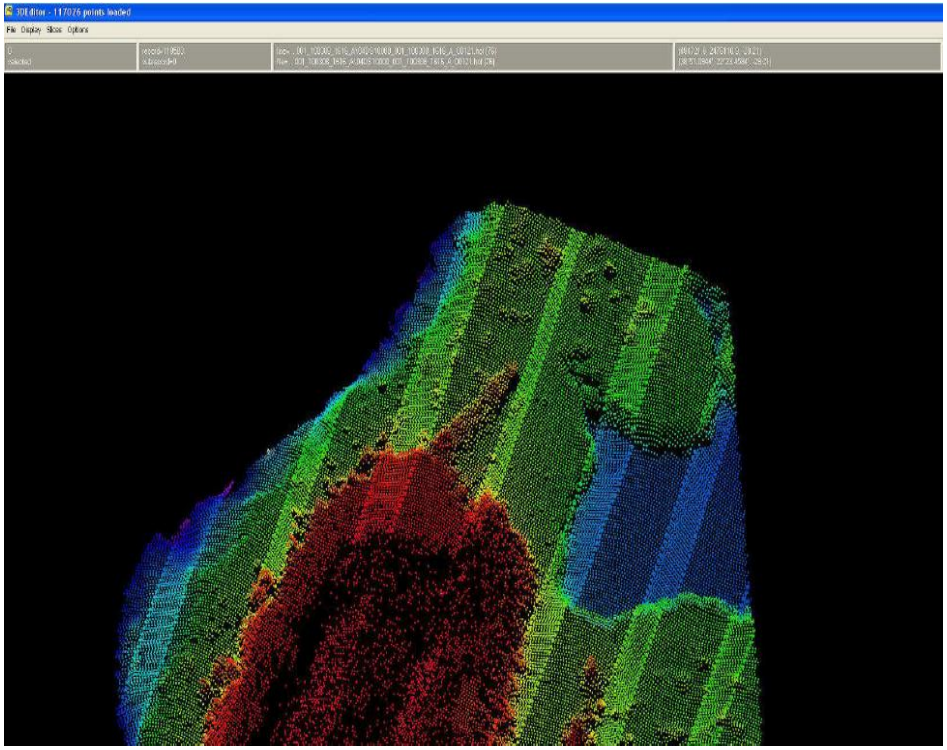
The reflectivity of an ALB pulse represents a measure of the amount of energy reflected from the seabed for each individual laser pulse at the wavelength of the laser, 532 nm (green/blue).

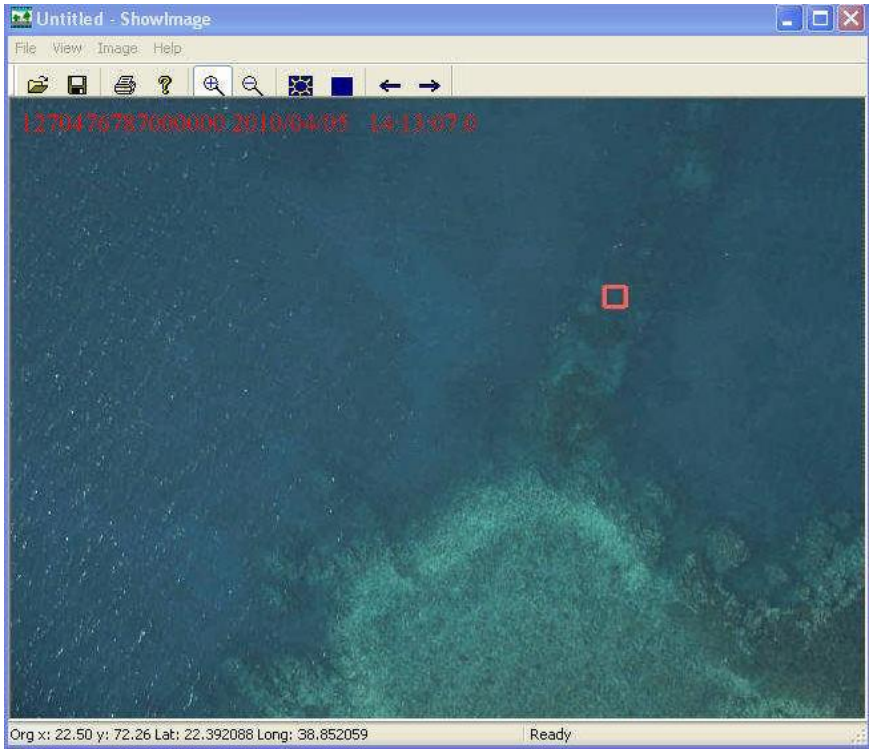
Sample Reflectance from Brazil

Seabed Classification from Reflectance Imagery



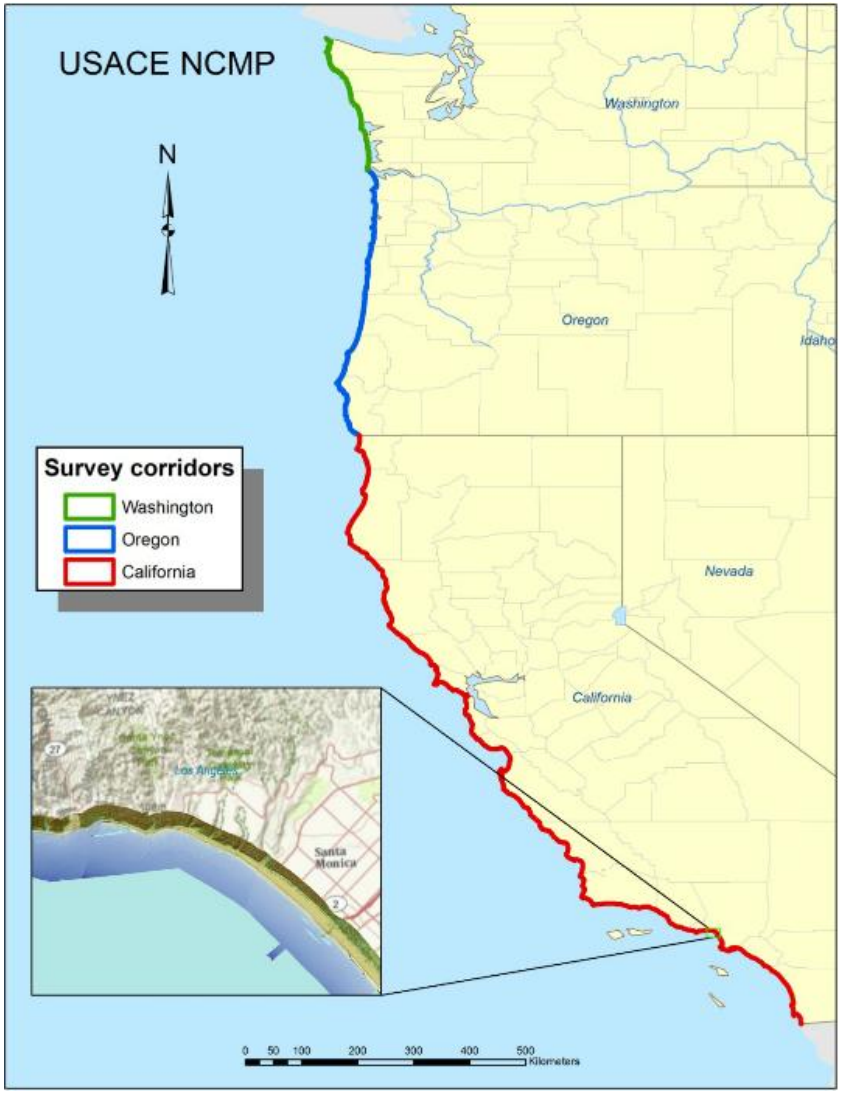
Additional Datasets – Digital Imagery





In addition, geo-referenced digital downward looking imagery is used in conjunction with the bathymetric and topographic data, particularly for the correct interpretation of cultural detail and specific shallow water feature identification/confirmation. Geo-referenced imagery is also useful to discriminate between boats, navigation aids and jetties in harbors and marinas.

Regional-Scale ALB Surveying: USACE NCMP

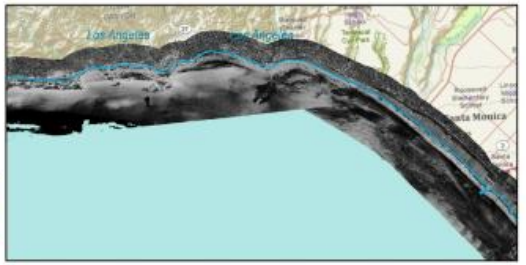


USACE NCMP U.S. West Coast

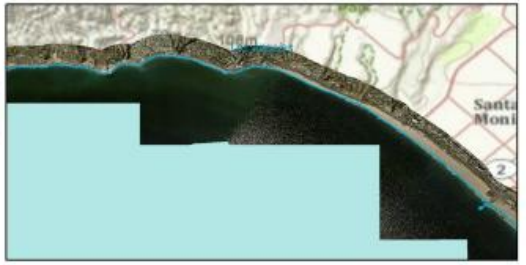
Sample Data Products Generated from Data Collected

Point Clouds and 1-m grid DEM

Reflectance and Intensity Imagery



Orthorectified Imagery

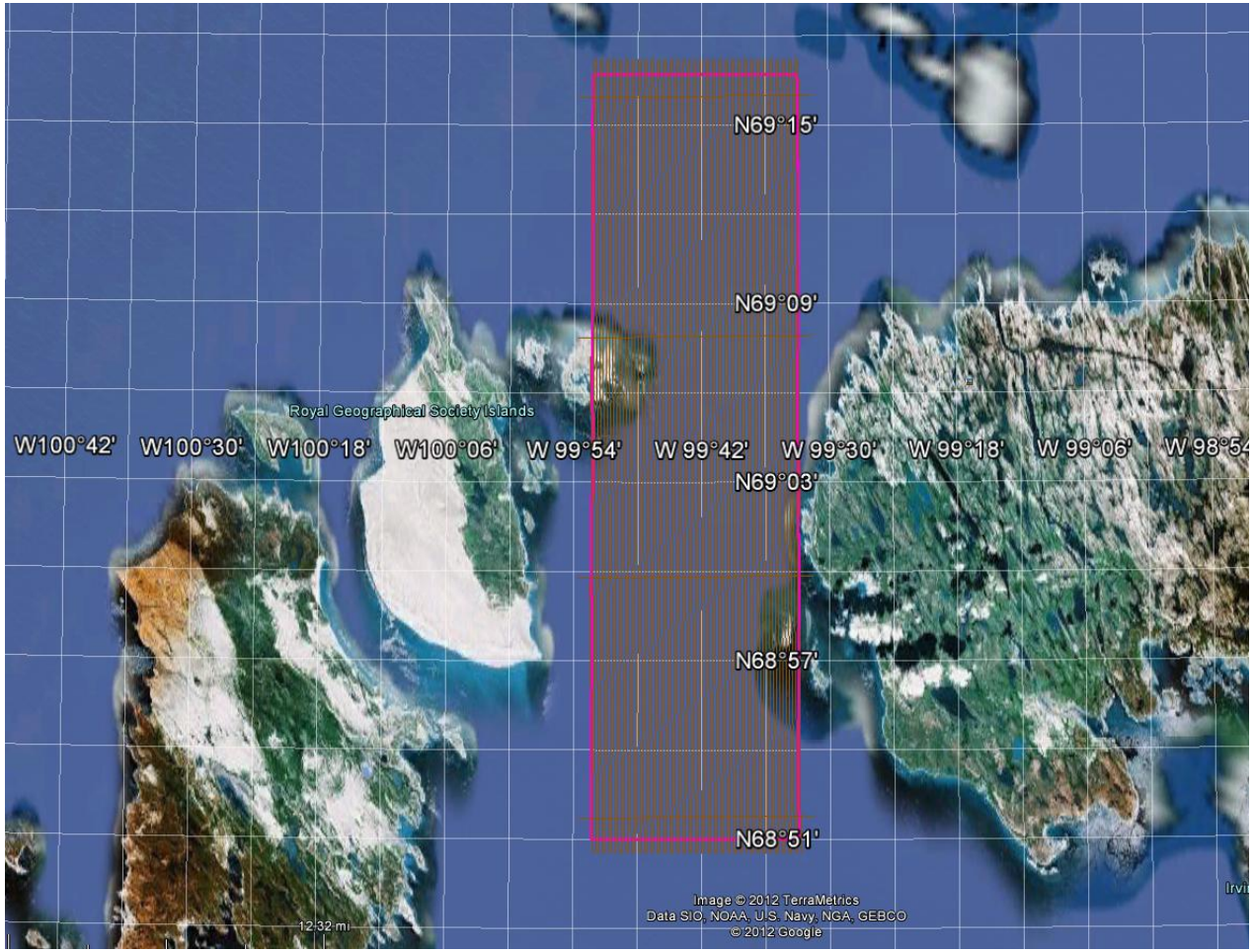


Area Map of Project

Fugro produced topographic and bathymetric point clouds (LAS and ASCII XYZ) from the ALS-60 and SHOALS-1000T systems, which in turn were used to generate 1-m resolution DEM.
Lidar data also produced reflectance and intensity imagery that, provide quailitative composition information of the seabed.
ADS-40 and SHOALS-1000T systems acquired digital imagery to produce uninterrupted high-resolution orthomosaics.

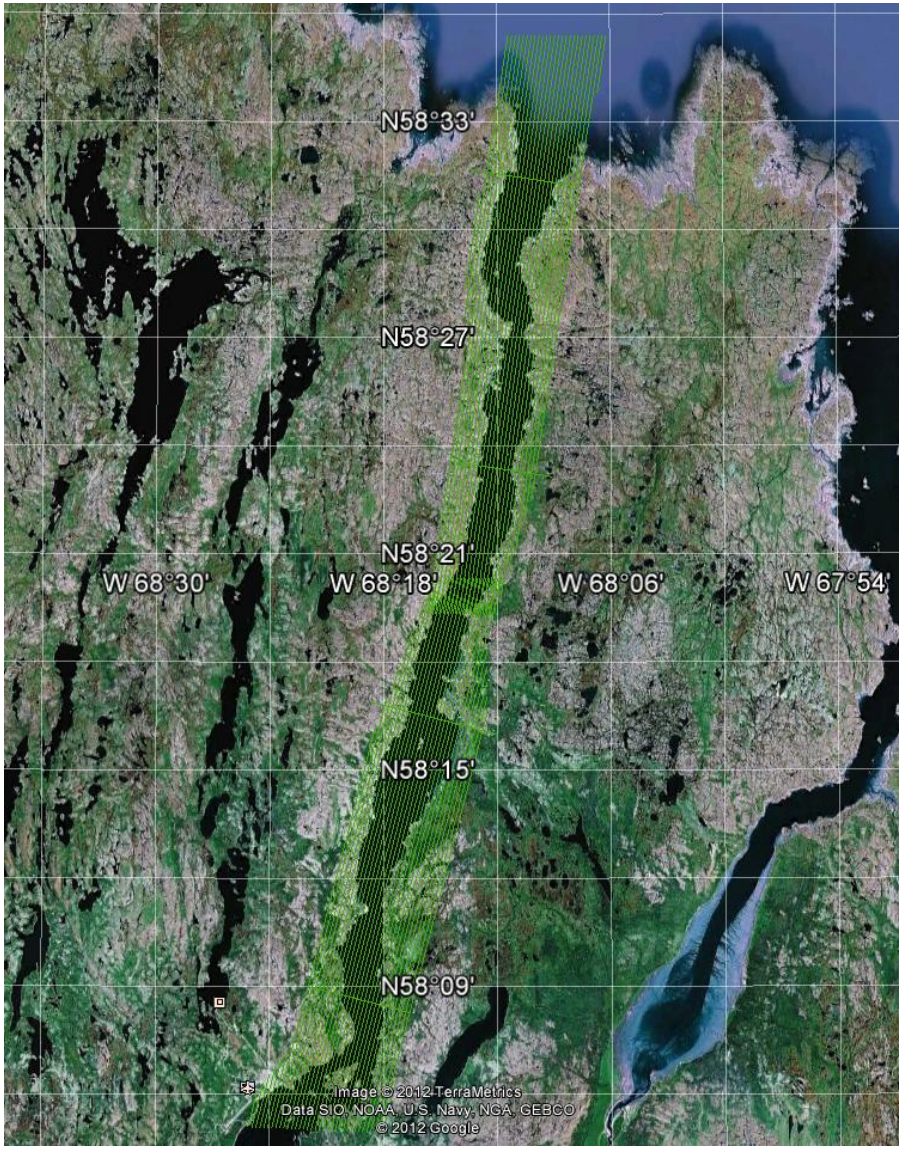
Good Planning: Good Survey Design

- RGS Islands, Northern Territories, Canada
- Approx. 26x6nm
- Variable bathymetry; some relatively low elevation islands
- Regular line plan only required to ensure coverage of whole area



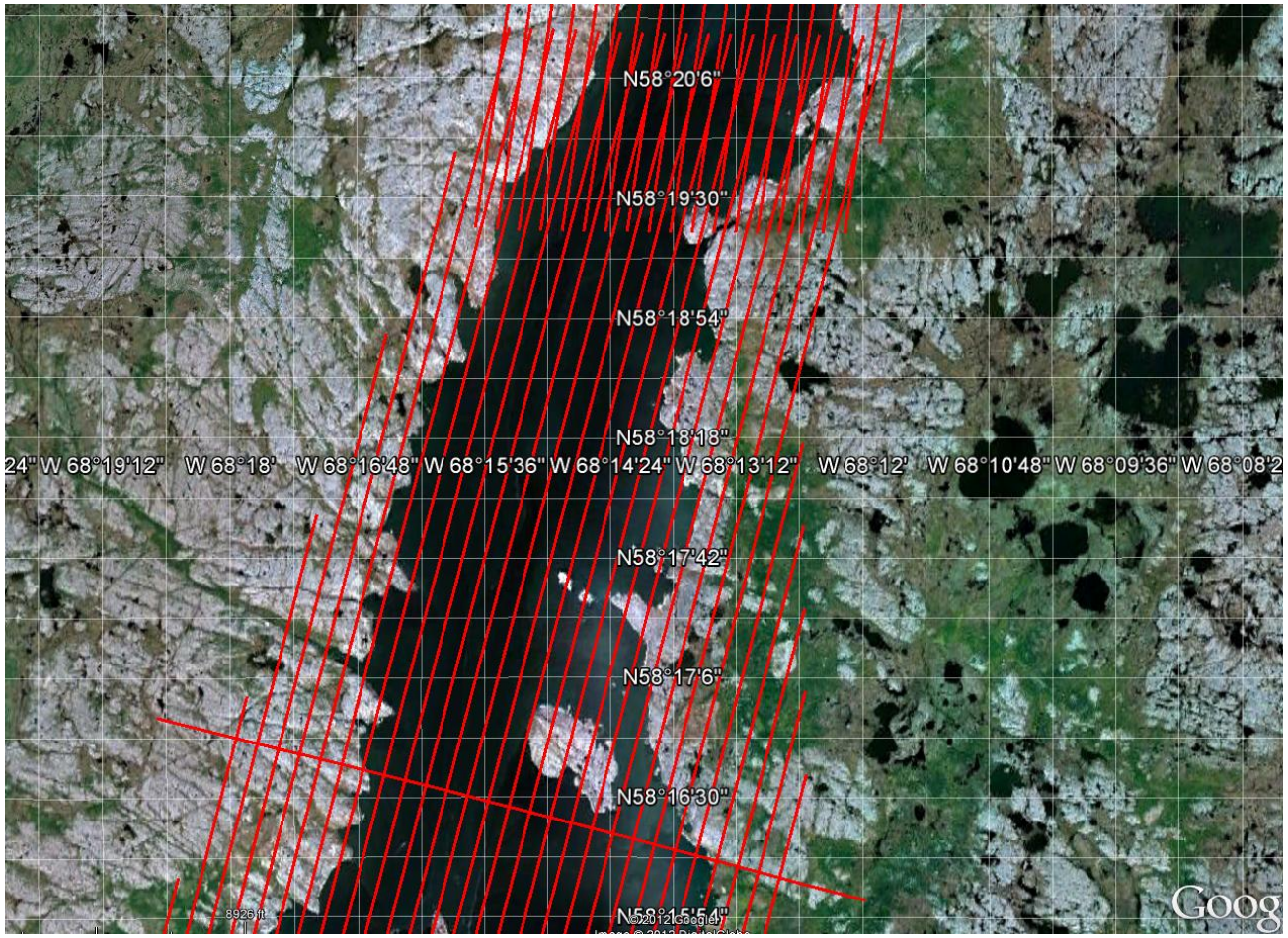
Good Planning: Good Survey Design

- Kuujjuaq, Quebec
- Long, complex fjord like estuary
- Only two line plans necessary to orientate and reduce small segments
- Survey planning software assists in designing optimum line plans



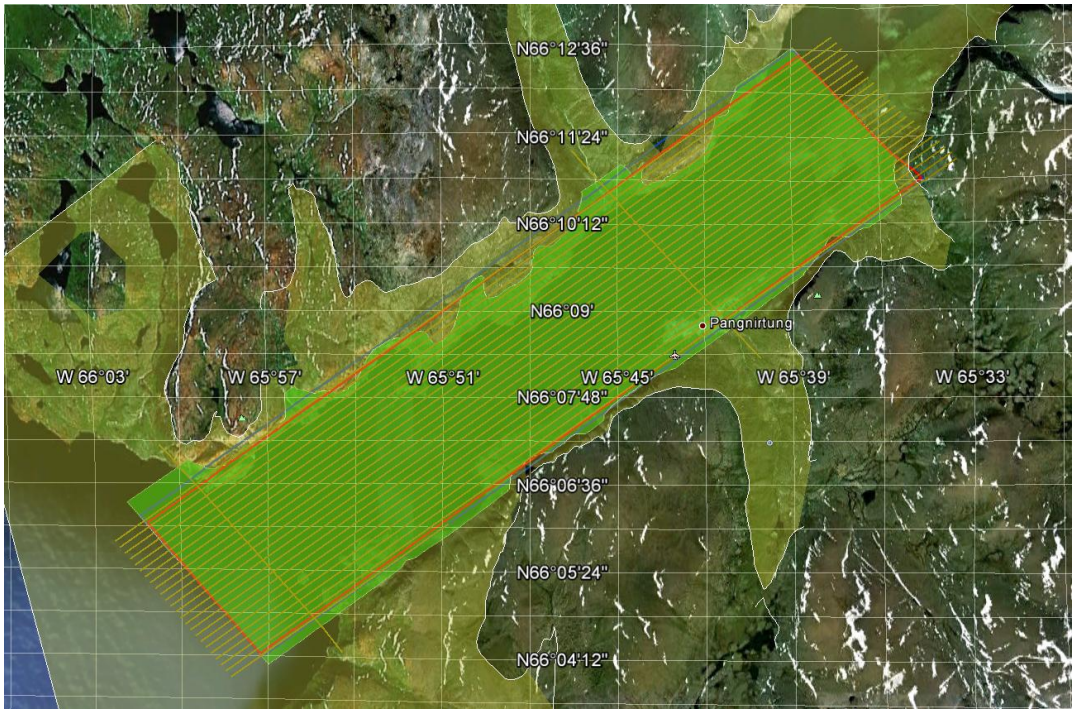
Good Planning: Good Survey Design

- The complexity of the coastline is not a major inhibitor to efficient line planning
- Note the crosslines are part of ALB surveys in exactly the same way as they are for MBES



Good Planning: Good Survey Design

- …Thus for any area one can begin to appreciate that the planning of surveys for ALB is radically different to that for MBES
- It is almost the obverse to what the MBES ‘safe’ polygon would look like
- This is where synergy in planning can reap huge efficiencies for a multi-sensor approach



Antarctic Proposal – Original Concept

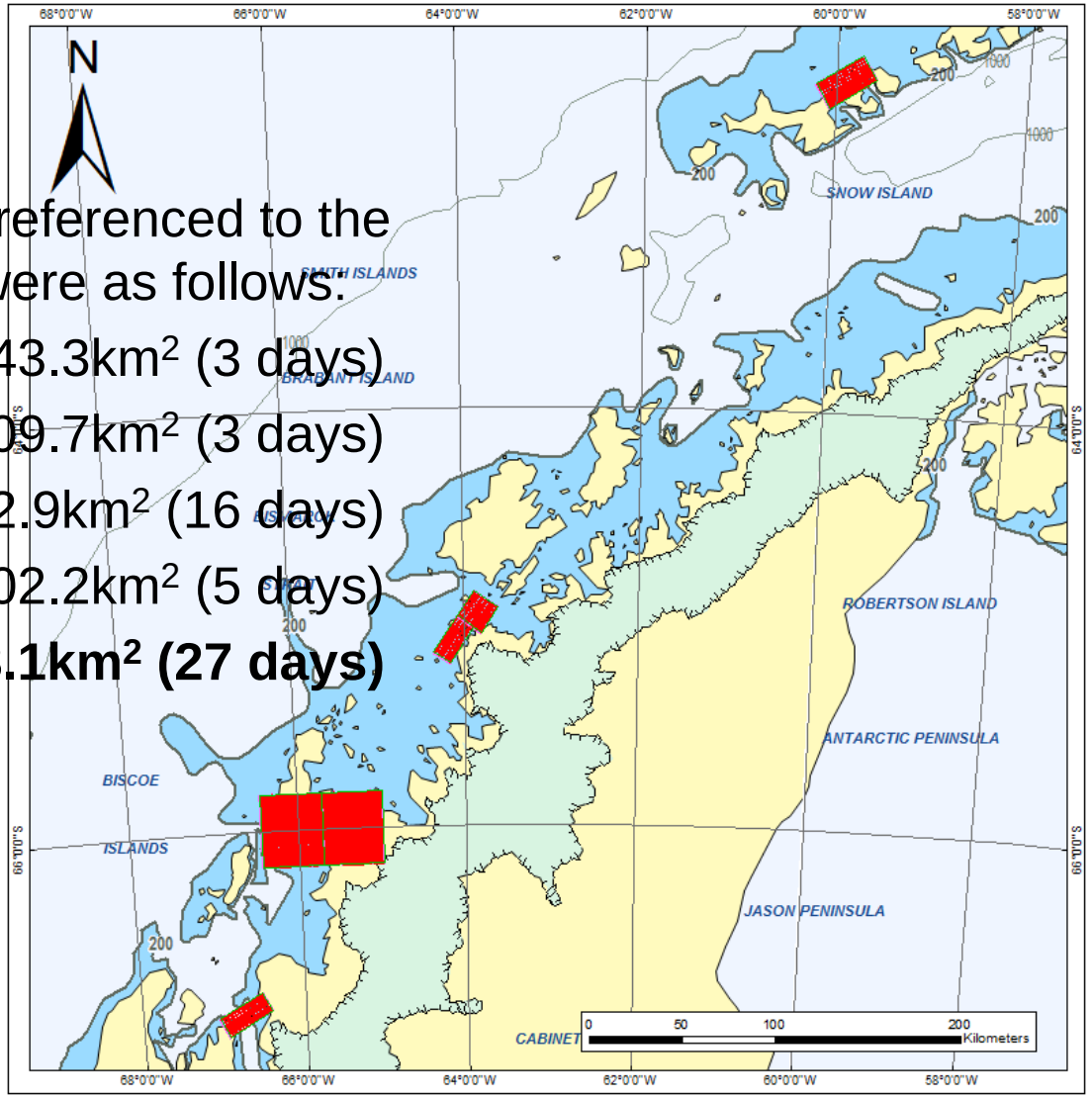
- Antarctic Peninsula Bathymetric LIDAR Initiative
- Draft proposal and Discussion document drafted for consideration by IHO
- Initially, proposed plan utilized service support on Antarctic Peninsula from BAS, based on surveys suggested by UKHO, and other support from SPRI
- Plan was to illicit support from UK FCO and present as a detailed Annex to the letter drafted by IHO for submission to ATCM
- In hindsight, this plan needs wider HCA support

Antarctic Proposal – Outline Planning

- The desktop environmental assessment indicated that the 20m isobath could be reliably attained
- All areas were outline planned on a 2.5m x 5m LIDAR spot spacing which would nominally be flown at 500m altitude, 160kn, providing a 290m swath and using a 30m overlap between lines to create 100% coverage as a minimum. In the depths concerned this would equate to complete seabed coverage.
- An operational day was assessed to average 2 flights providing 5.5hrs of data collection; this is conservative as the Antarctic summer would yield plenty of daylight for further flights (weather permitting)
- The standby day was set at 1:1 with operational days

Antarctic Proposal – Areas under consideration

- The four areas in the plan (referenced to the local Admiralty Chart No.) were as follows:
- Antarctica 776 443.3km^2 (3 days)
- Antarctica 3570A 309.7km^2 (3 days)
- Antarctica 3570B 2542.9km^2 (16 days)
- Antarctica 446 502.2km^2 (5 days)
- **TOTAL AREA 3798.1km^2 (27 days)**



Antarctic Proposal – Logistic Scenarios

- Option 1 (considered unlikely): Full commercial responsibility – Fugro supplies everything incl. aircraft, shipping to Antarctica via South America. Assume fuel expensive at about $10pg. Assume accommodation at maybe Govt. per diem rate in Antarctica.
- Option 2 (possible): Fugro-supplied aircraft again but Govt. support for fuel, logistics and accommodation etc. in Antarctica. Shipping from Punta Arenas (by air) to Antarctic for system and personnel (probably separately).
- **Option 3 (preferred):** Fugro supplies system and personnel, all aircraft support and logistics, accommodation etc in Antarctica supplied by Govt (nil commercial cost line). Shipping only to South American airhead, thence nil cost to Antarctica.

Antarctic Proposal - Deliverables

- Acquisition and standby was calculated at 27 days each for the Level Of Effort (LOE) to complete all areas, all processing and the generation of a standard suite of products; these included:
  - Cleaned and edited ASCII XYZ point files of hydrographic LIDAR data
  - DTM of cleaned and edited hydrographic LIDAR data in ArcGIS format
  - Raw RGB imagery in JPG format with associated ASCII world file
  - Metadata
  - Descriptive report documenting all operations
- Optional deliverables included:
  - Ortho-rectified photo mosaics in Geotiff format

Thank You