Survey Presentation:
Lidar & MBES; Planning Aspects and Cost Considerations

Presentation for the
Meso-American and Caribbean
Hydrographic Committee (MACHC)

Don Ventura, Fugro Pelagos Incorporated

22 November 2012

Company Profile

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

Resources

14,000 Employees

70 Vessels

75 CPT Trucks

27 Laboratories

29 Jack-up Platforms

60 Aircraft

250 Land-based Drill Rigs
17 Offshore Drill Rigs

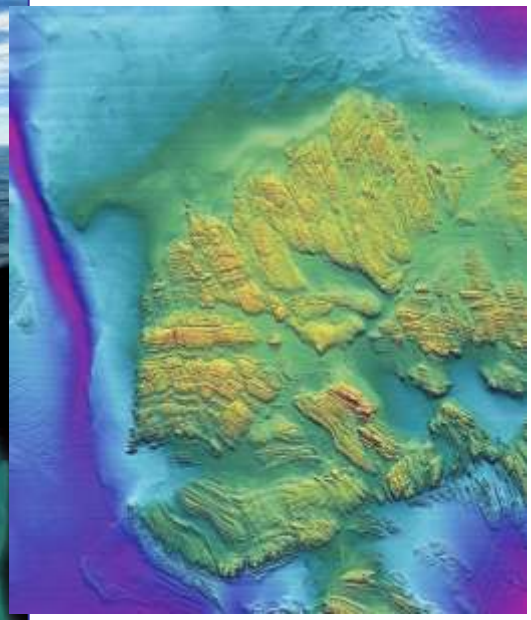
151 ROVs

8 AUVs

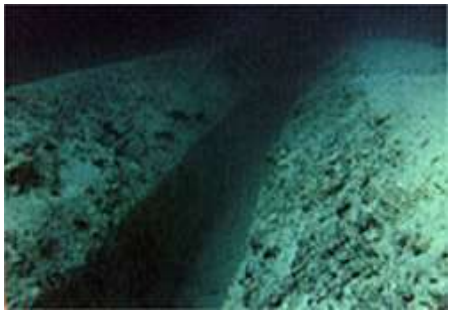
282 Offices

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

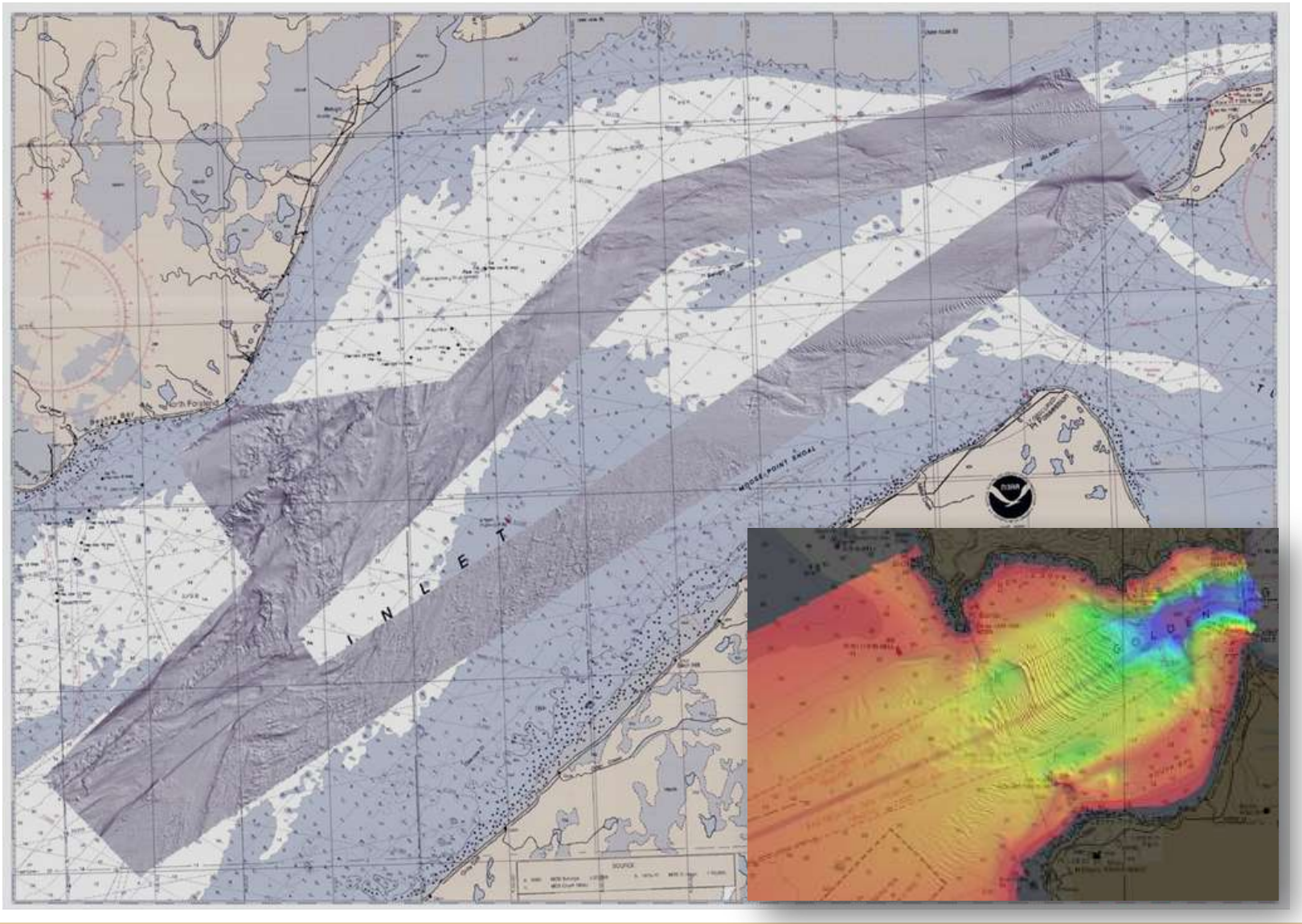
Fugro Pelagos Services & Products



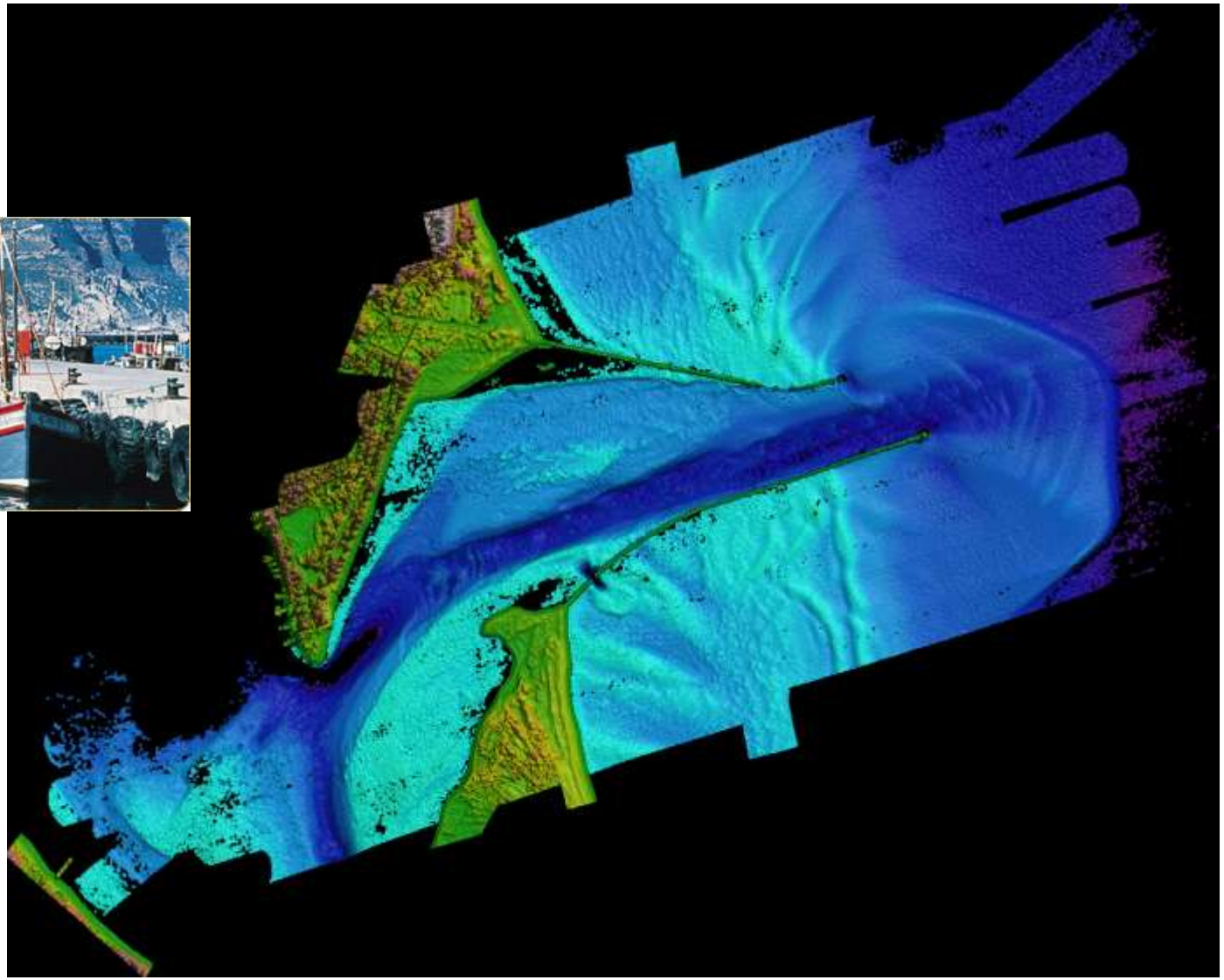
- Services Lines
  - Hydrographic Surveying/Charting
  - Cable Route Survey
  - Coastal Zone Mapping
  - UNCLOS/EEZ
  - Ports and Harbors Survey
- Product Lines
  - Positioning software
  - Positioning signals



Hydrographic Charting



Ports & Harbor Surveys

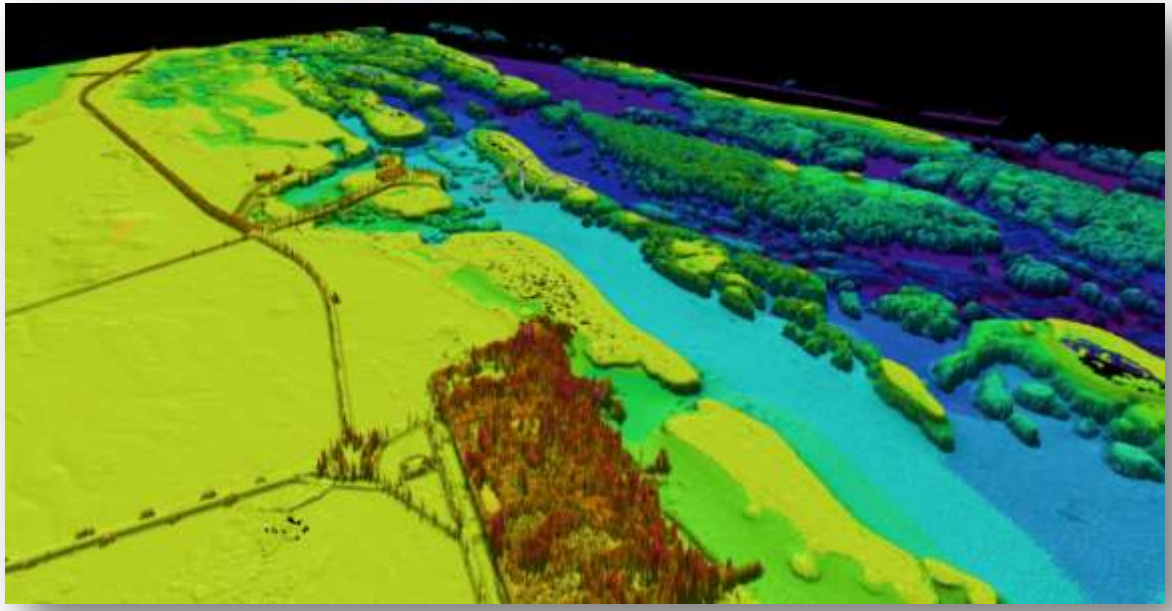


ALB Overview – All Current Systems

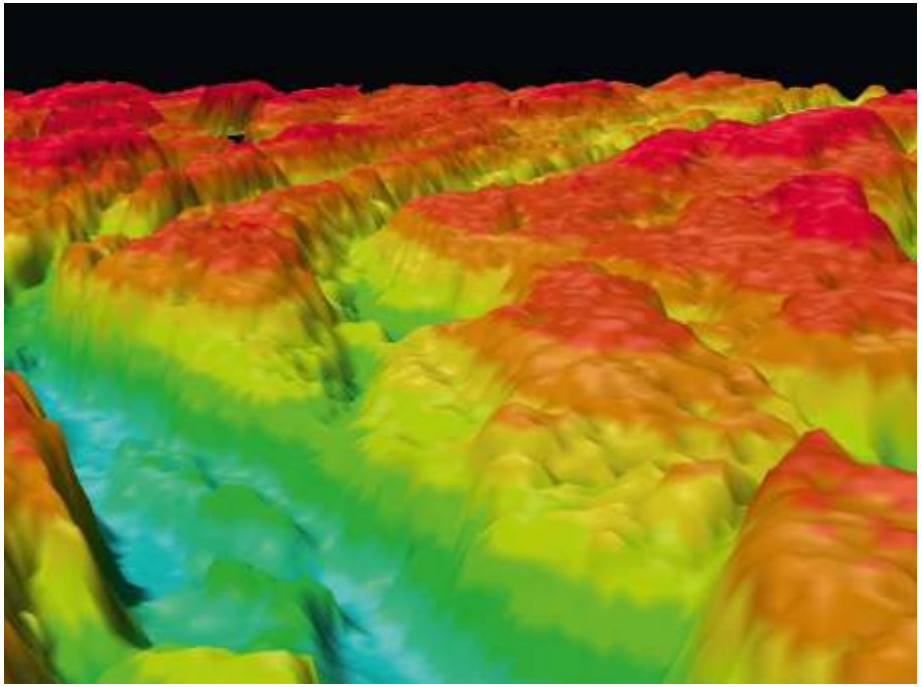
- 1000 - 3000Hz prf (output)
- Nd:YAG pulsed dual frequency lasers
- 532, 1064nm (green and near-IR)
- IR reflects from sea surface; green from seabed (and surface too)
- Orientation and navigation through IMUs (Applanix POS AV510 typical)
- All include multi-mp digital cameras firing at 1Hz; resolution 8-30cm

Fugro ALB Systems: Optech SHOALS 1000T

- Optech SHOALS 1000T
  - 2000Hz
  - Nd:YAG pulsed dual frequency laser
  - 532, 1064nm (green and near-IR)
  - IR reflects from seasurface; green from seabed
  - Orientation and navigation through Applanix POS AV410 IMU
  - Includes 8mp digital camera firing at 1Hz; resolution 8-20cm



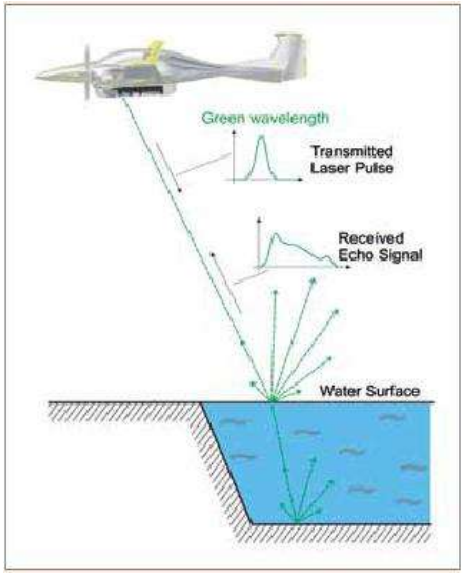
Fugro ALB Systems: Fugro LADS Mk3

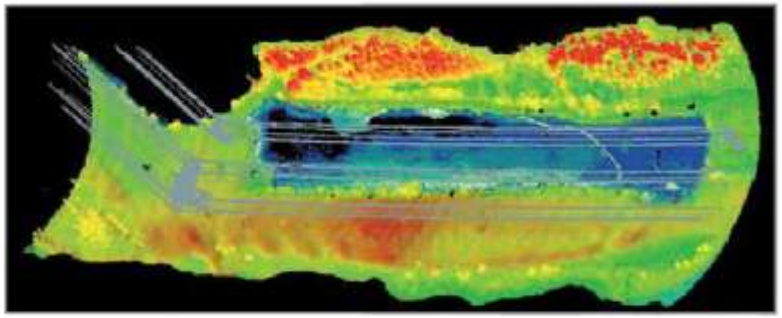


- System designed and built by Fugro ALB
- Capable of meeting IHO Order 1a
- High powered laser capable of depths to 80m subject to environmental conditions
- Large aperture receiver and automatic gain control for superior system performance
- Efficiently utilizes aircraft of opportunity
- Designed for continual upgrade and enhancements

Fugro ALB Systems: Riegl VQ-820-G

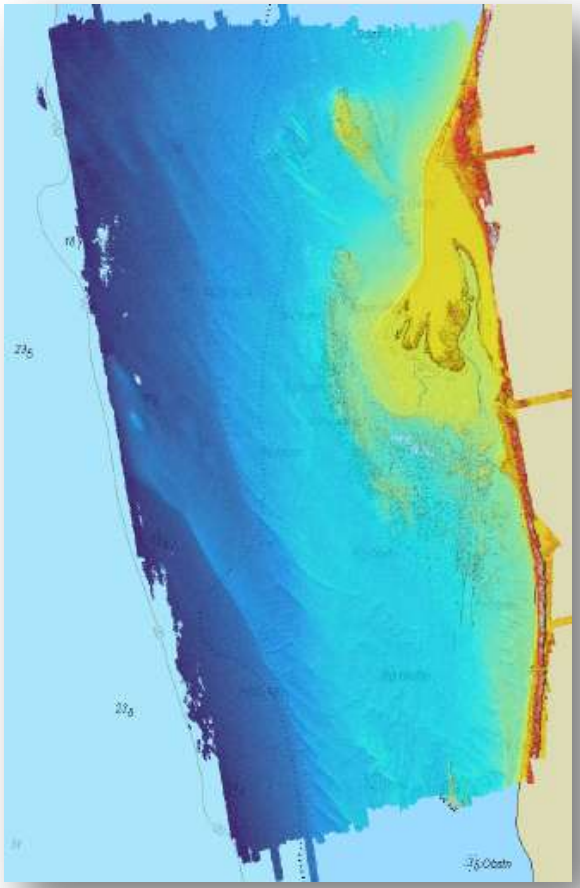
- Developed by RIEGL Laser Measurement Systems
- System purchased in 2012 (co-owned by FPI and FLC)
- 250 KHz Laser; only 26kg
  - Suited for topo and hydrographic survey
  - Coastline shallow water mapping
  - Riverbed profiling



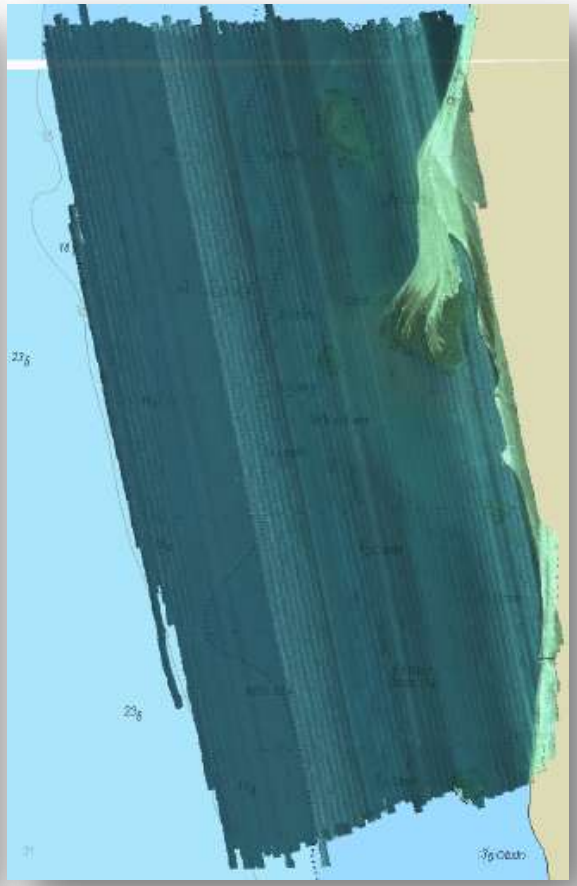


ALB systems can operate from fixed or rotary wing aircraft

Multiple products from single acquisition



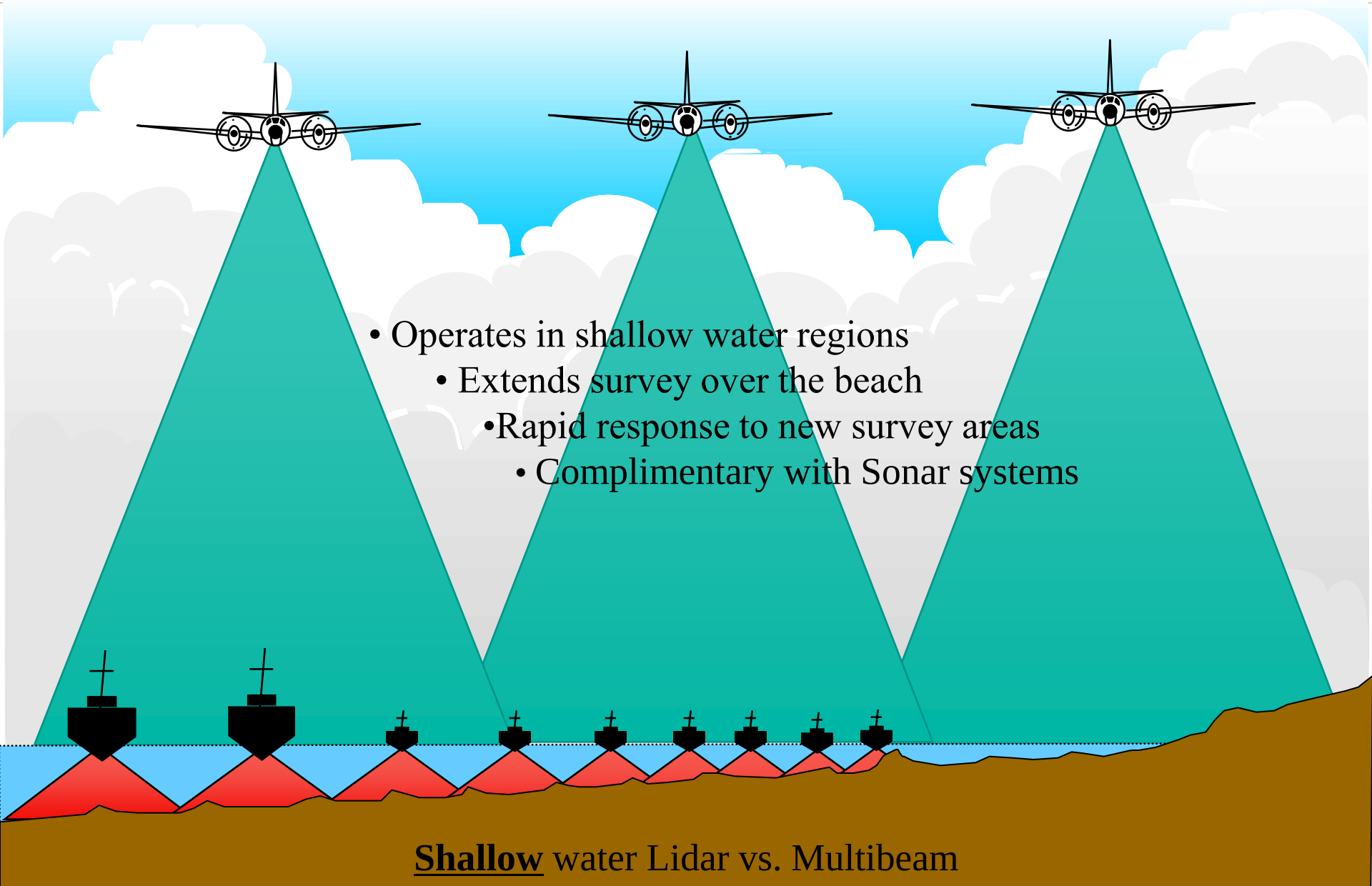
Bathymetry



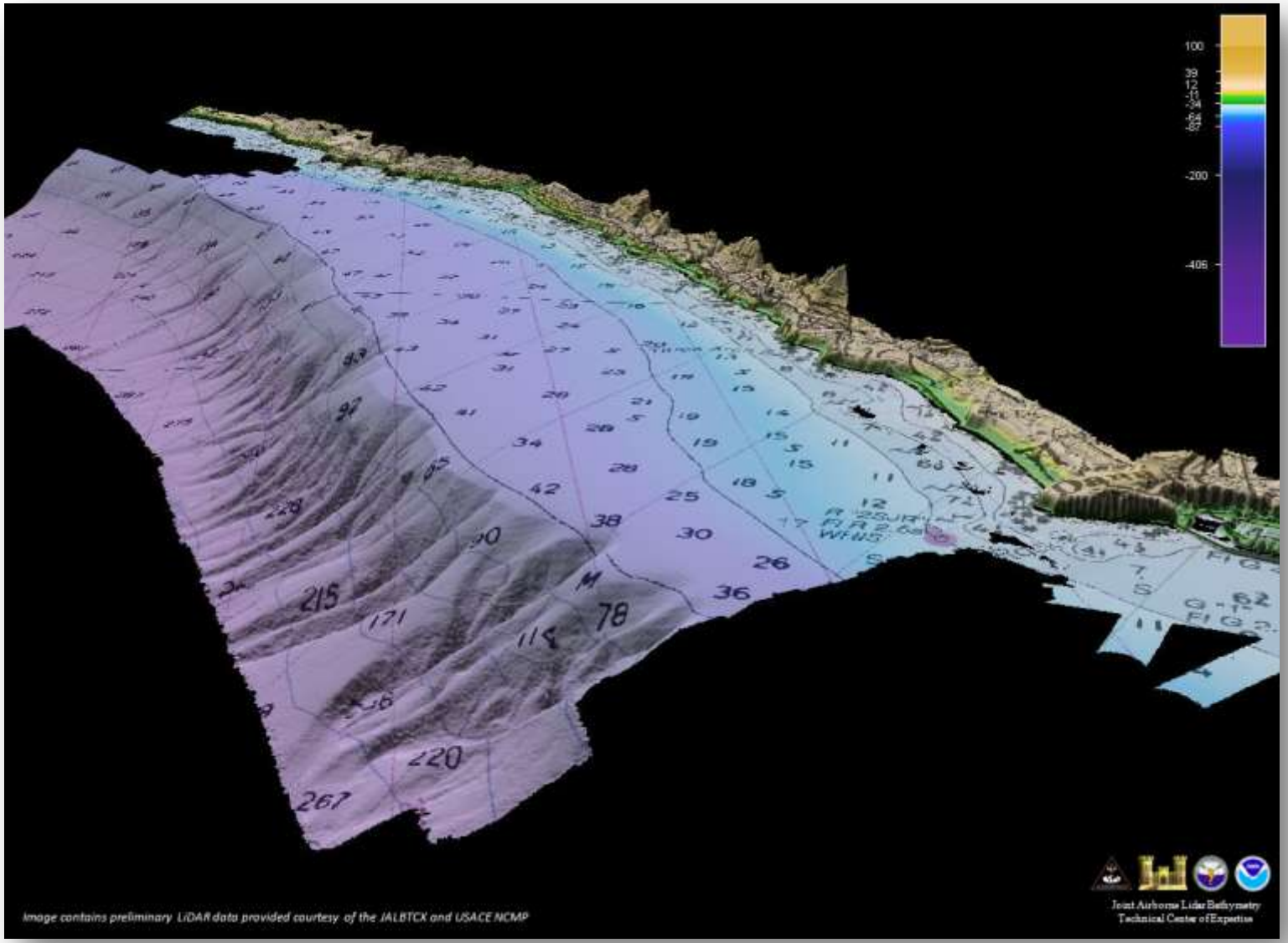
Imagery

Reflectance

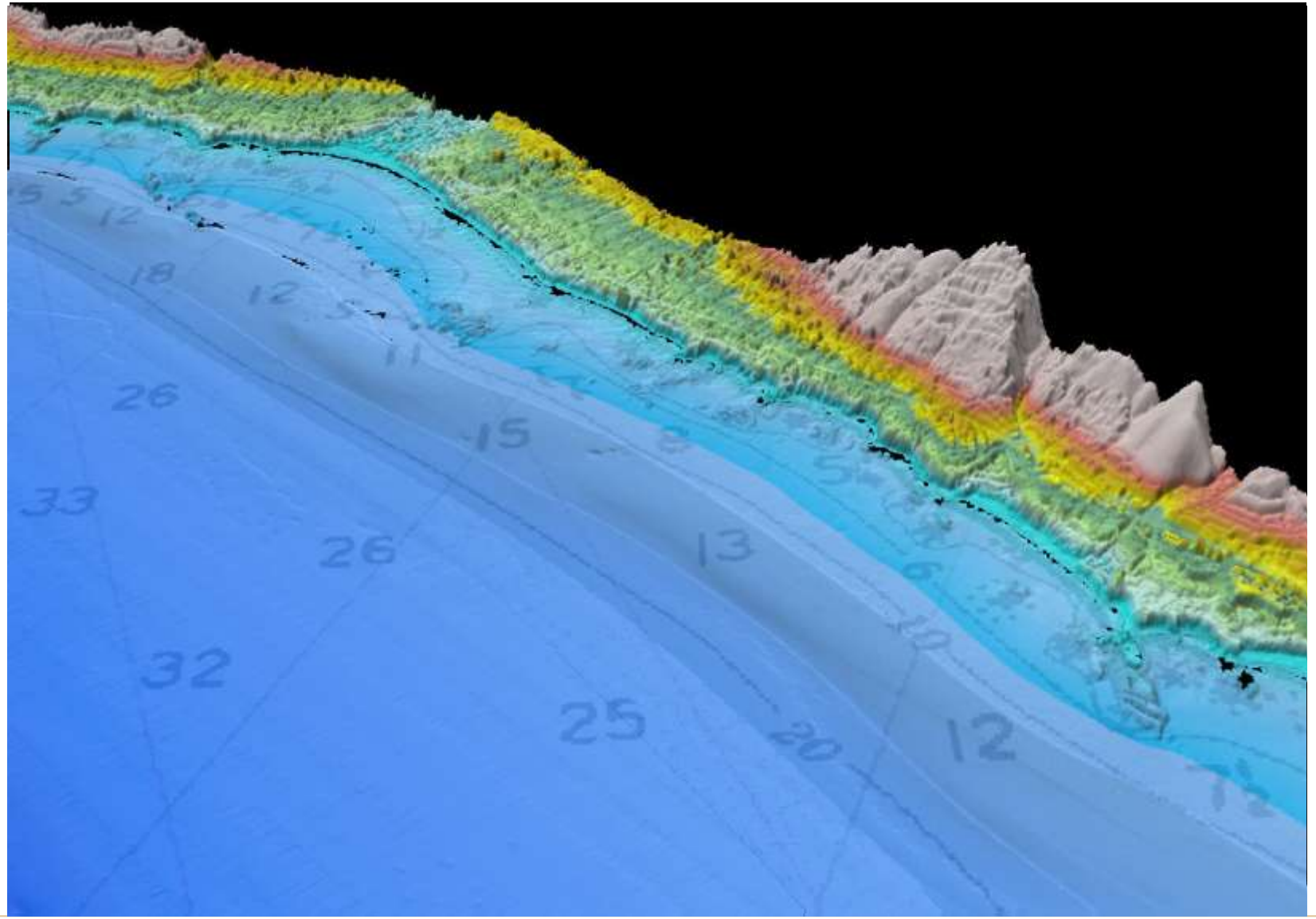
Advantages of Airborne LIDAR



Integration of MBES with Topo and bathy LiDAR delivers seamless dataset



Closing the Gap with ALB



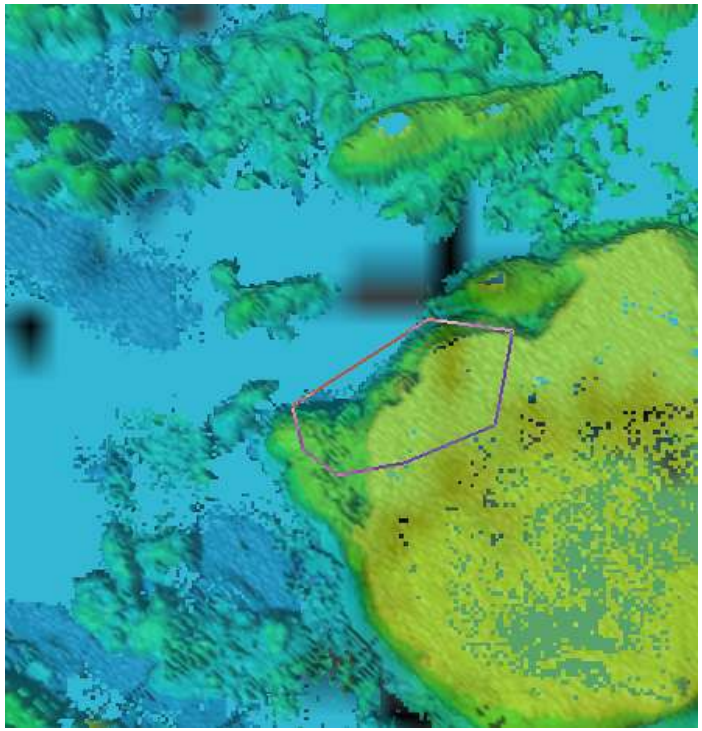
Operational and Logistical Considerations

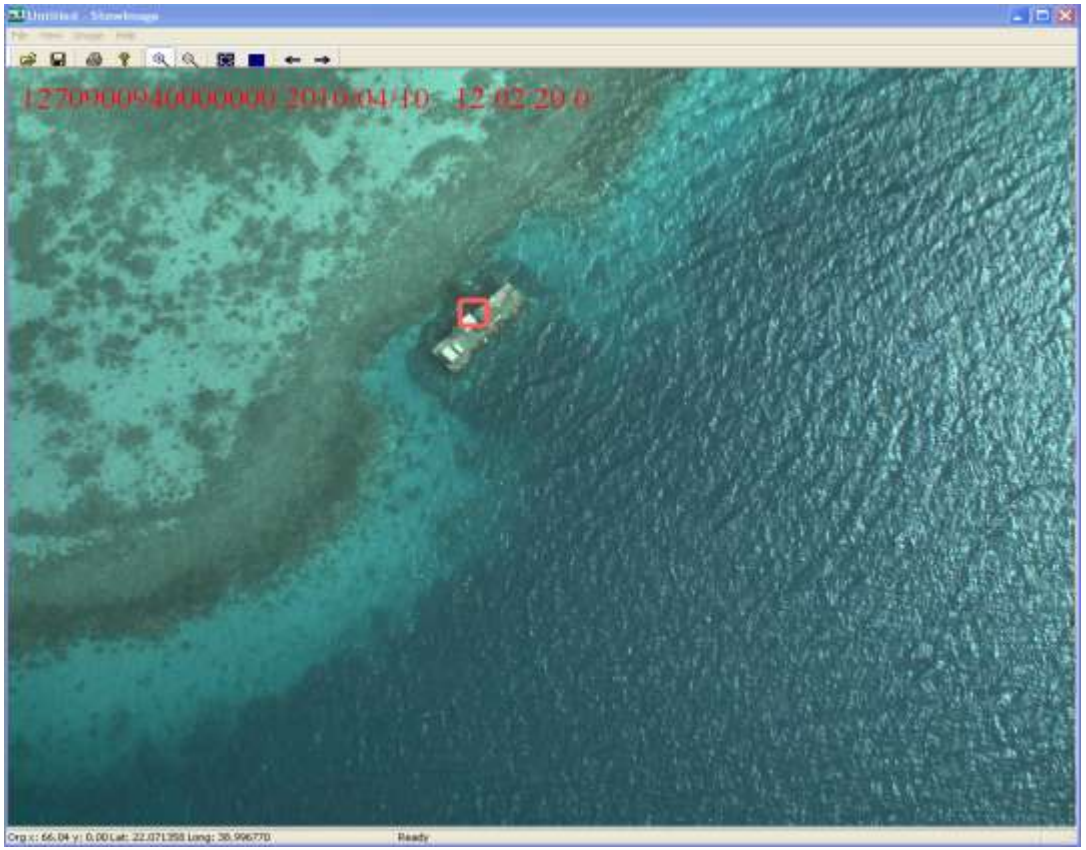
- A ship has a typical operational endurance (all limits considered) of between 20-30 days; an aircraft suitable for ALB operations has an endurance of about 4-7 hours (more if you can afford to operate a big aircraft)
- A ship remains afloat and usually continuing operations when it carries out routine maintenance; an aircraft needs a fully servicing airport to do the same and is OOA during that time
- Both ships and aircraft need a place to dock, though a lot less frequently for a ship
- An aircraft needs daily refuelling
- The aircrew require a regular rest pattern for FAA safety impositions
- Space for the mission suite is much more restrictive in an aircraft
- Power availability is much more restrictive in an aircraft
- The mob/demob LOE for remote aircraft operations necessitates fairly lrge projects to justify the expense/increase overall project efficiency
- A ship is much more independent than an aircraft and can fully support its crew; an aircraft needs a land base with support infrastructure

Operational and Logistical Considerations (cond)

- However…
- A ship surveys at approx 3-5ms^{-1}; an aircraft travels at 70-100ms^{-1}
- A good to average turn from one line onto another in an aircraft is about 2 mins; this equates to approx 8.4 km in linear flight @ 70ms^{-1}
- Efficient surveys must therefore be linear in design; a 10km long survey block is barely 50% efficient in theory and less in practice
- Coverage can be anything from 70-200+km^2 per day with an aircraft, irrespective of the water depth or ruggedness of the terrain above and below the water
- Safety considerations and hazards to platform navigation are entirely different for ships and aircraft
- For ships, bathymetry is the main consideration to platform safety
- For aircraft, topography is the main consideration to platform safety
- Despite the single-digit kHz pulses compared to the 100s of kHz for MBES, daily data collection rates (approx 15Gb per flight) are comparable (due to the metadata, full waveform extraction required for ALB)

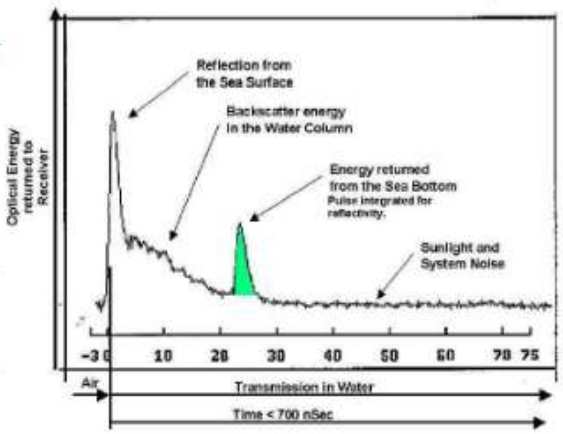
Additional Datasets – Digital Imagery





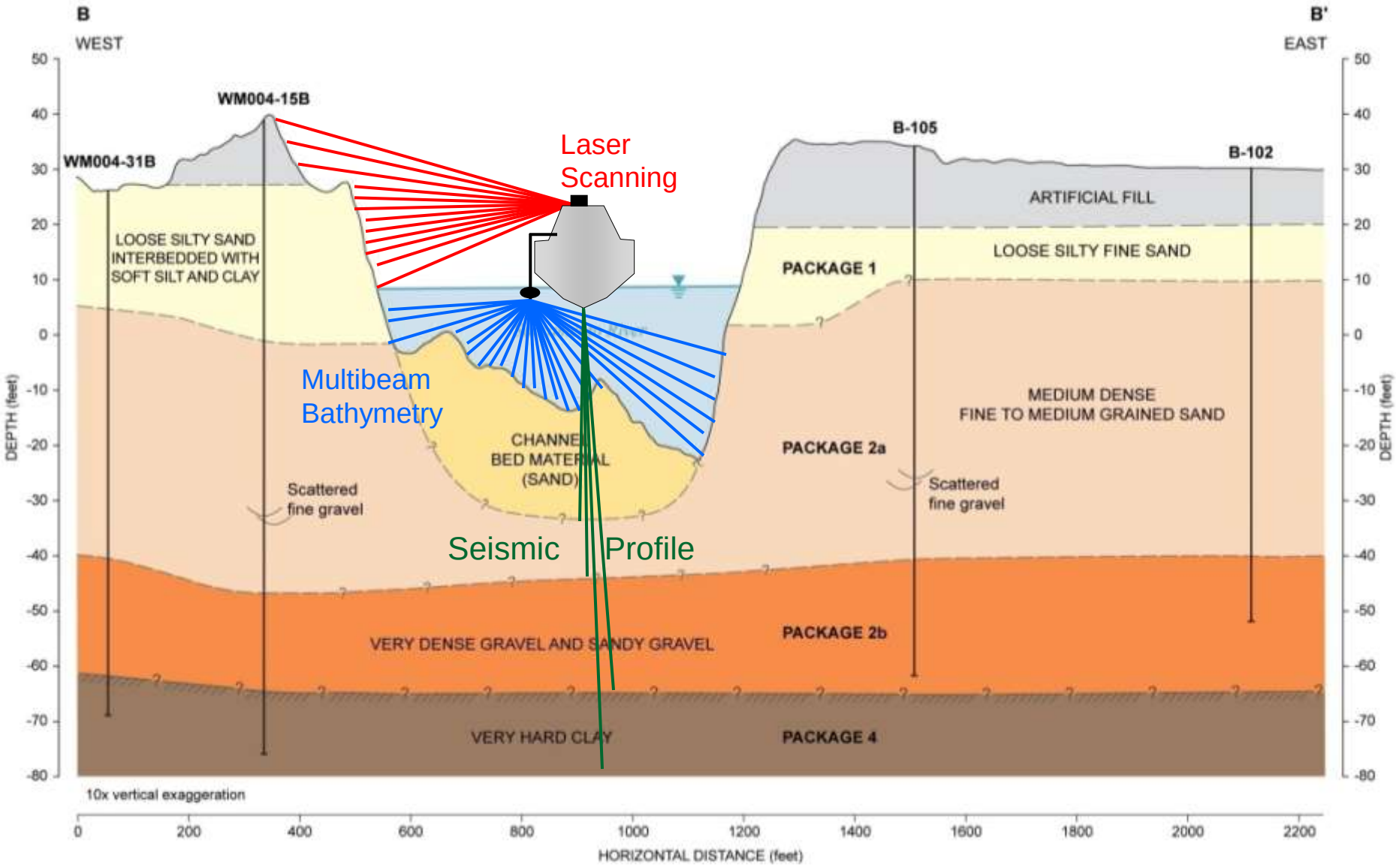
In addition, geo-referenced digital downward looking imagery is used in conjunction with the Lidar data, particularly for the correct interpretation of cultural detail. For example, the geo-referenced imagery is useful to discriminate between boats, navaids and jetties in harbours and marinas, or to identify isolated anomalies as above.

Additional Datasets – Reflectivity

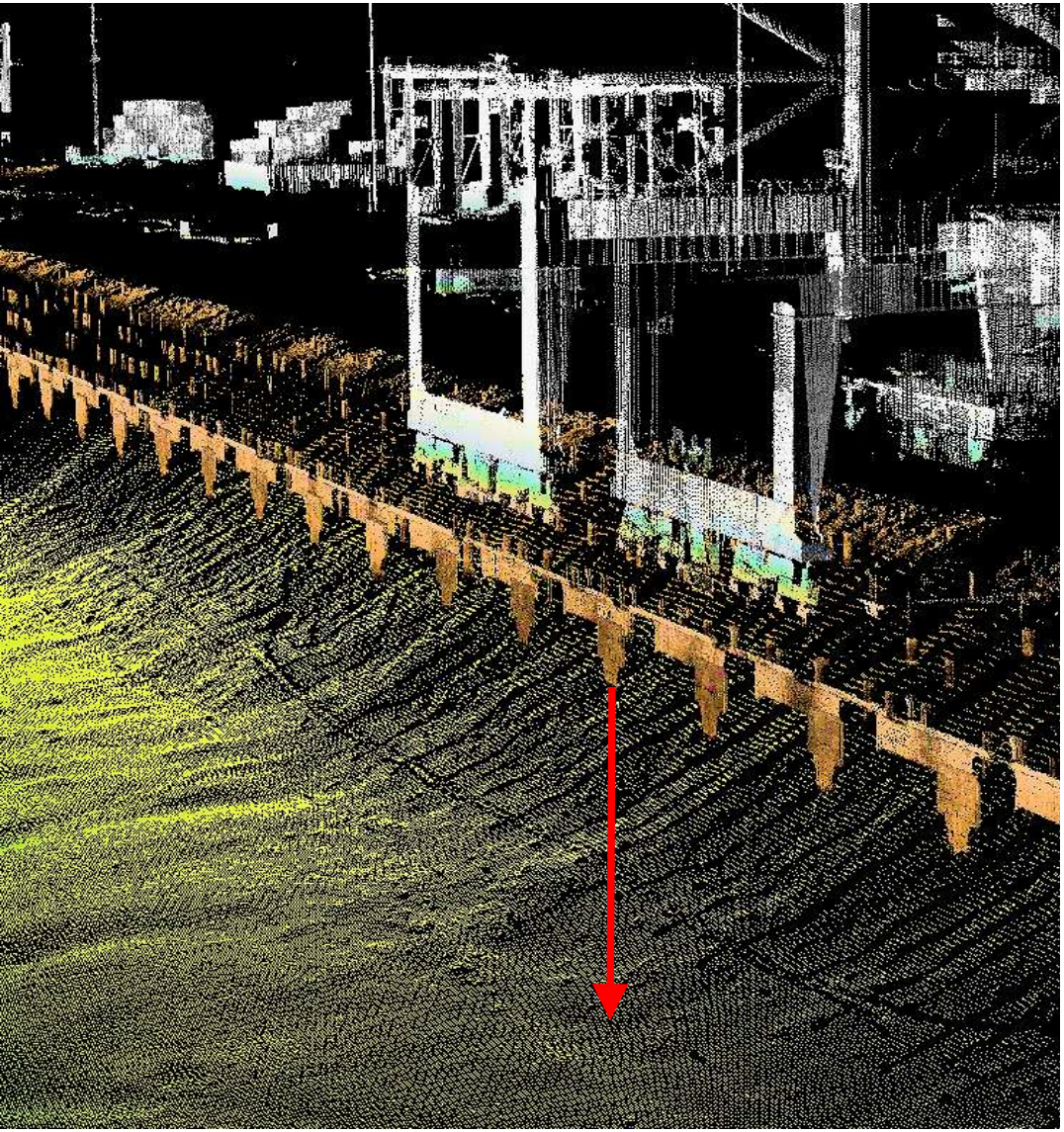


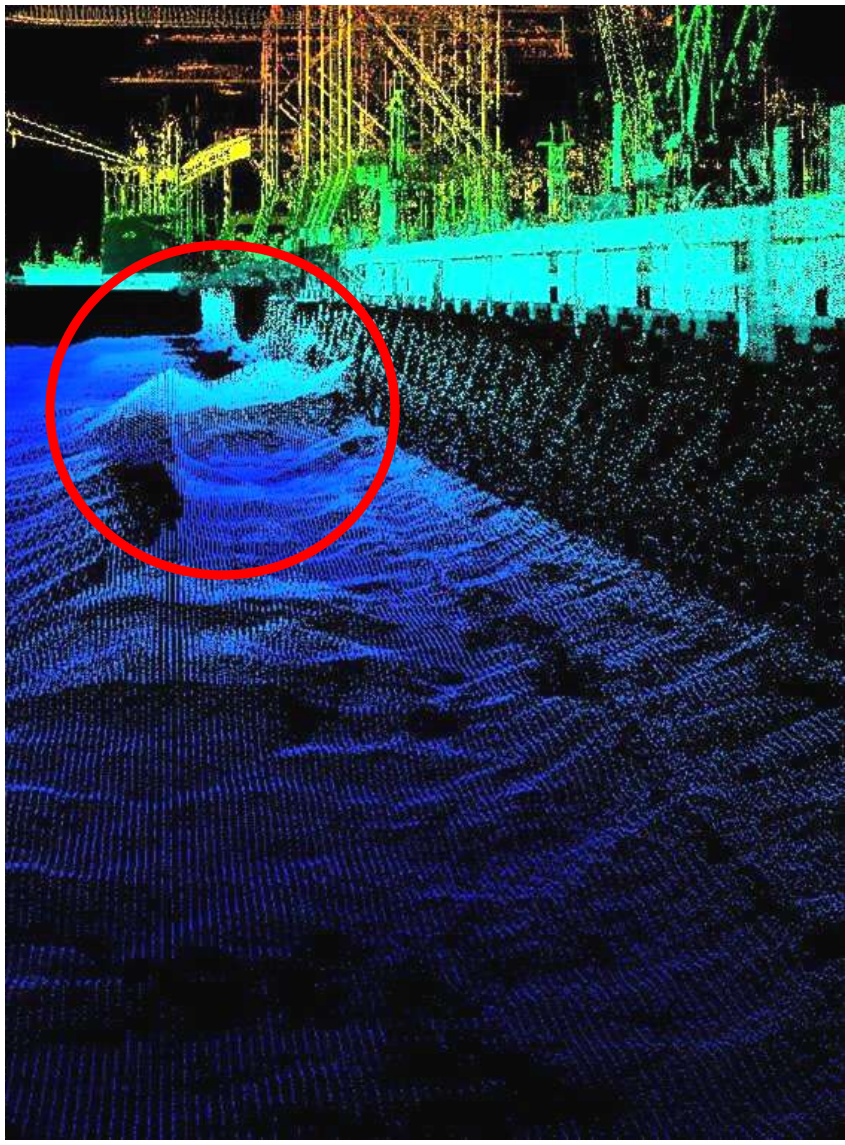
The reflectivity of an ALB pulse represents a measure of the amount of energy reflected from the seabed for each individual laser pulse at the wavelength of the laser, 532 nm (green/blue).

Fugro BOATMAP – Operational Concept



BOATMAP – High Resolution Port Infrastructure





Cost Considerations

- Elements include
  - Effective and Non-iterative planning
  - Shipping/Deployment
  - Mobilization/Demobilization
  - Data Acquisition
  - Processing: Location and Complexity
  - Reporting
  - Deliverables/Products

Cost Considerations

- Planning needs to be effective and the requirements for survey clearly stated by the Client
  - This should include a pre-tender Stakeholders meeting hosted by the Client
  - All needs and wants are thereby included in the Tender
  - Day rates or cost per area/line km might be appropriate for different projects
- Mobilization etc can eat into a survey budget very rapidly
  - Small jobs should be ‘necklaced’ so that a single mobilization will suffice to deploy to an area and complete all tasks for that season/year
  - We try and execute small projects on the way to/from larger regional tasks
  - Industry aims to try and keep this element at about 10-15% of the overall project cost if at all possible
- Data acquisition relies heavily on planning being effective pre-deployment: working with the Client to iron out issues with permitting etc is vital

Cost Considerations

- Processing is usually conducted in two stages:
  - Field
  - Office
- Unless the project is considerable or regional in nature, office processing is most cost-effectively conducted at the Contractor's own facilities
- Reporting, Deliverables and products try and emulate the structure of the Tender (as does the Proposal)
  - …so this is best created on a template which is easy to break out for the various Stakeholders
  - …conforms to international standards for data accuracy, density and format
  - …and is fully recognisable by the Contractor (to avoid iterative and avoidable effort)

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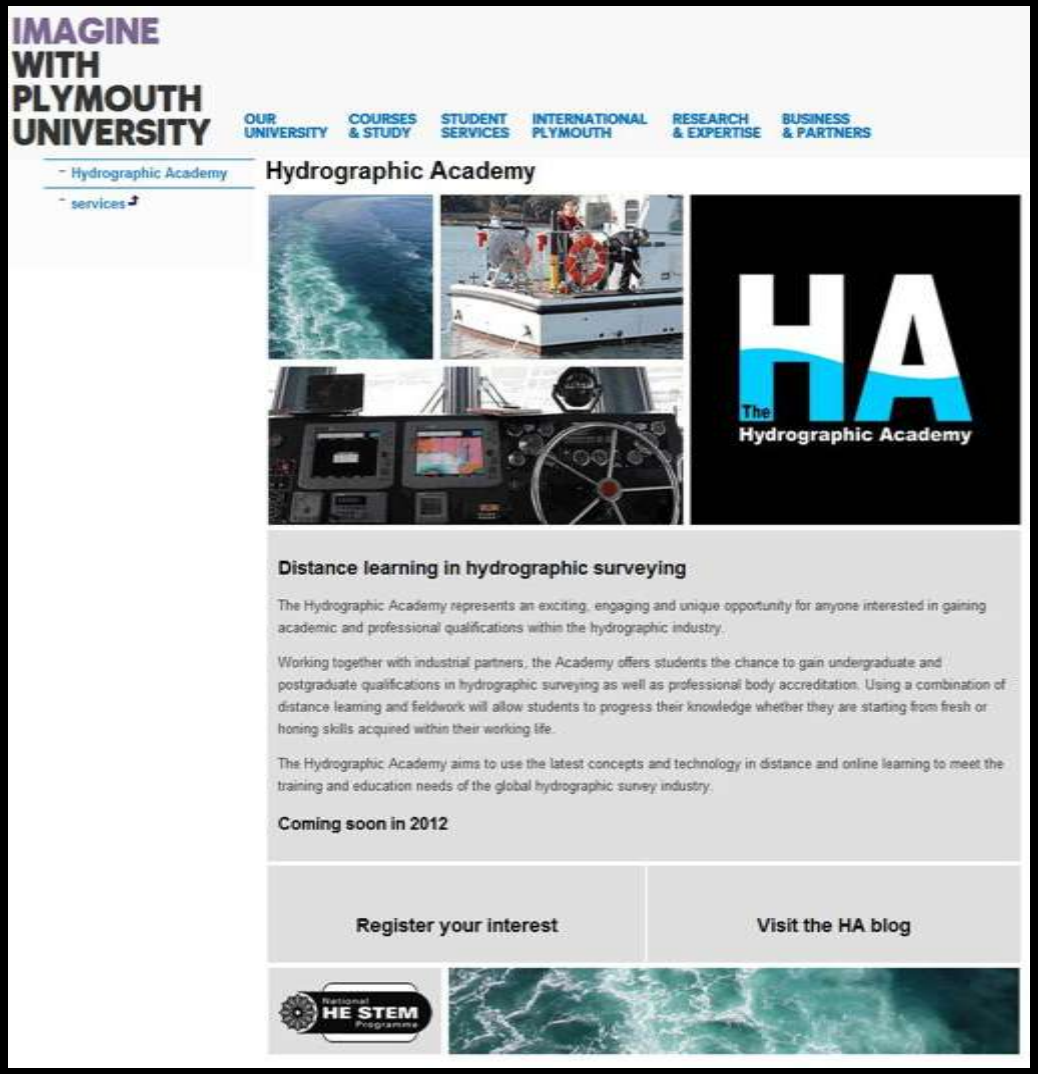

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- Whole modules self-contained on a USB stick
- No need for an internet connection
- Tutor support by email/Skype
- Online discussion area

Thank You