Hydrofest 2020

The Hydrographic Society in Scotland

Survey Sensors

17/04/2020

Danny Wake

Chief Surveyor

i-Tech 7 - A Subsea 7 Brand

Survey Sensors

- Acoustic positioning
- Measuring depth
- Attitude sensors
- Doppler velocity logs & Inertial navigation
- Cameras, lasers & 3D imaging sensors
- Sonars / Echosounders
- Sound velocity sensors
- Pipe & cable detection systems
- Sidescan sonars
- Sub bottom profilers

Background

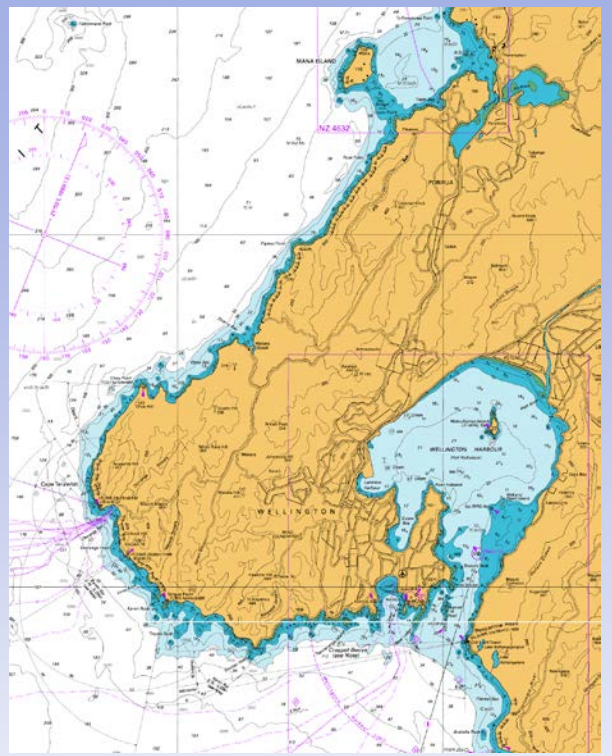
- Historical perspective
- Survey platforms

Applications

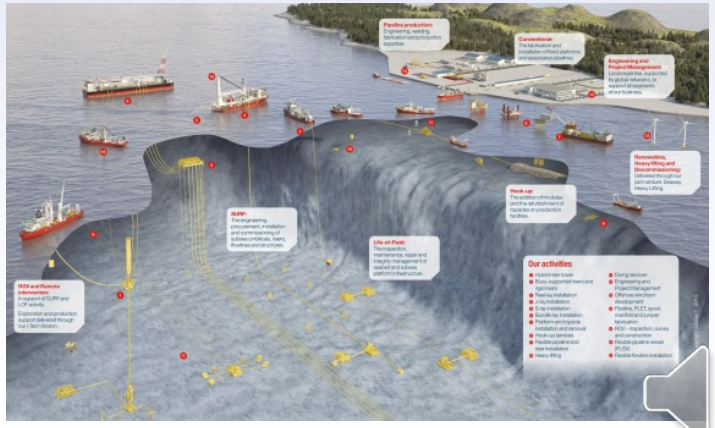
- Construction support
- Site surveys
- Pipeline & cable inspection
- Renewables applications
- Subsea metrology
- Decommissioning

What do we need hydrographic sensors for?

- For pure hydrographic surveying:
  - Depth measurements
  - Hazard identification
  - Seabed composition
  - Tides & currents
  - Water column information



- For construction survey
  - Identifying suitable seabed (composition, topography, stability)
  - Positioning infrastructure within tolerance
  - Installing infrastructure at the correct attitude and elevation
  - Assessing integrity during and after installation

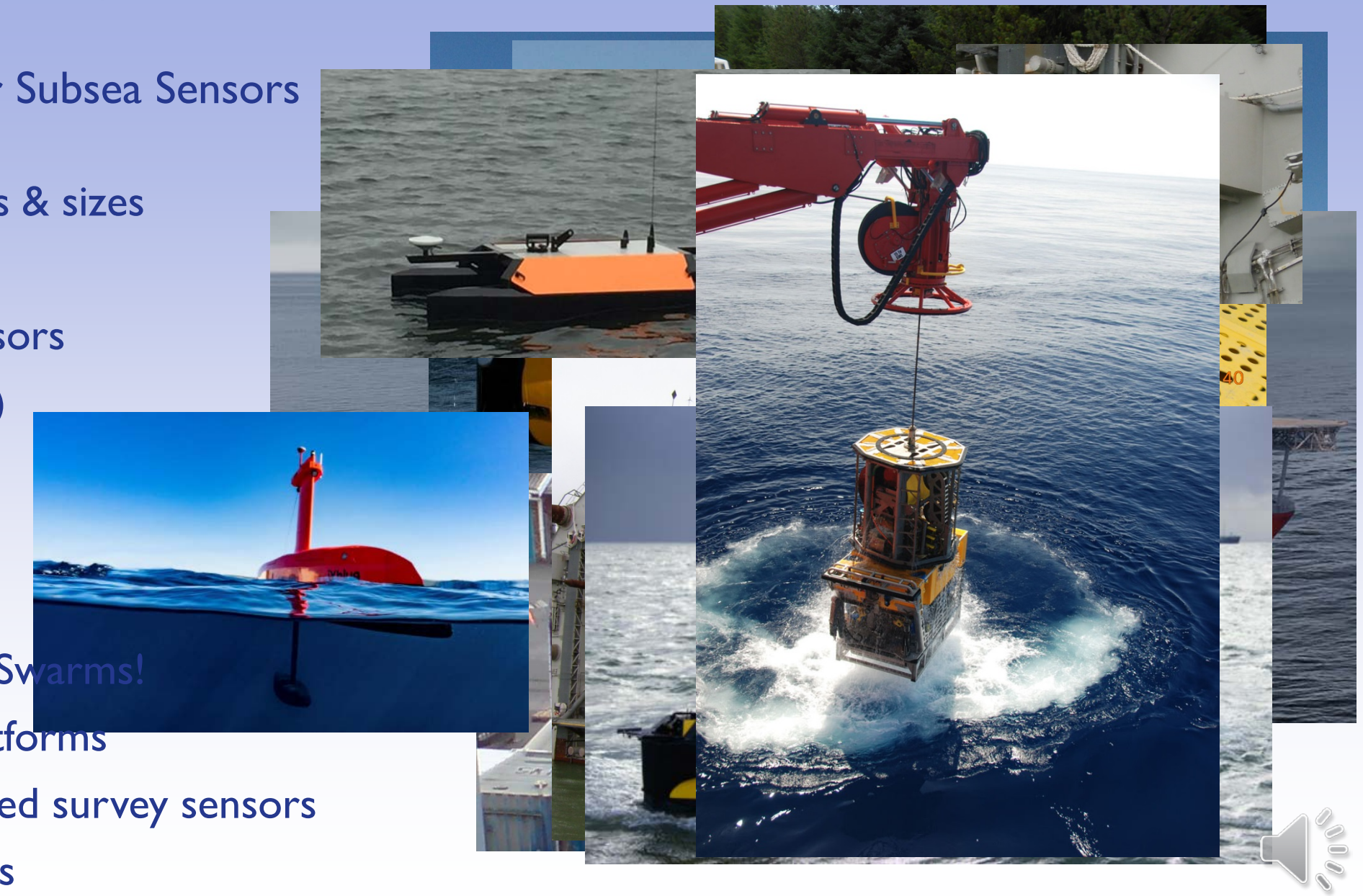


What is a suitable survey platform?

Other end of the scale

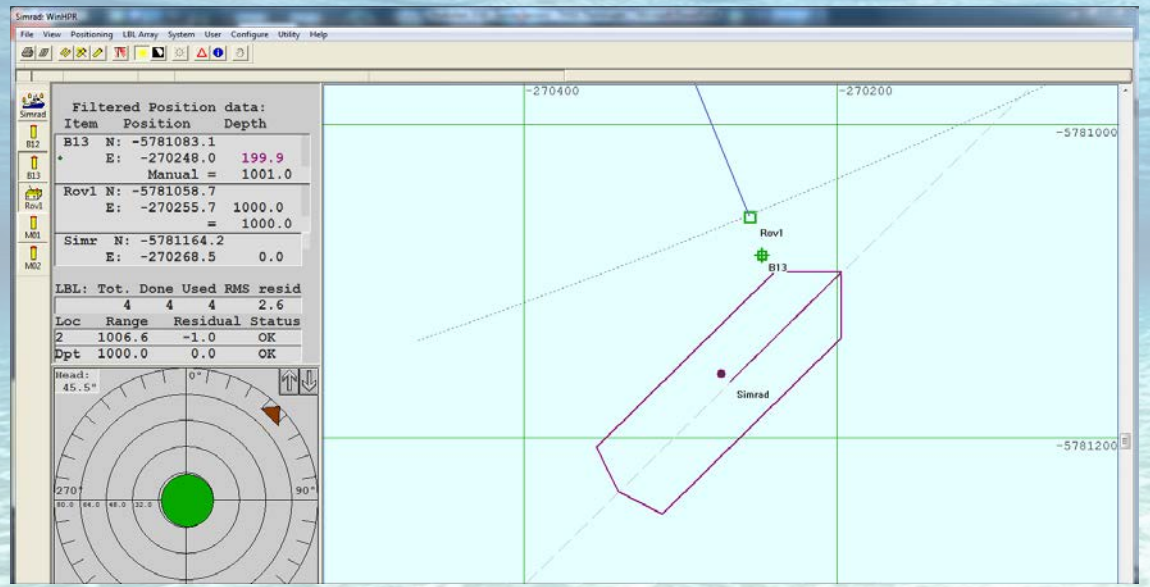
Typical platforms for Subsea Sensors

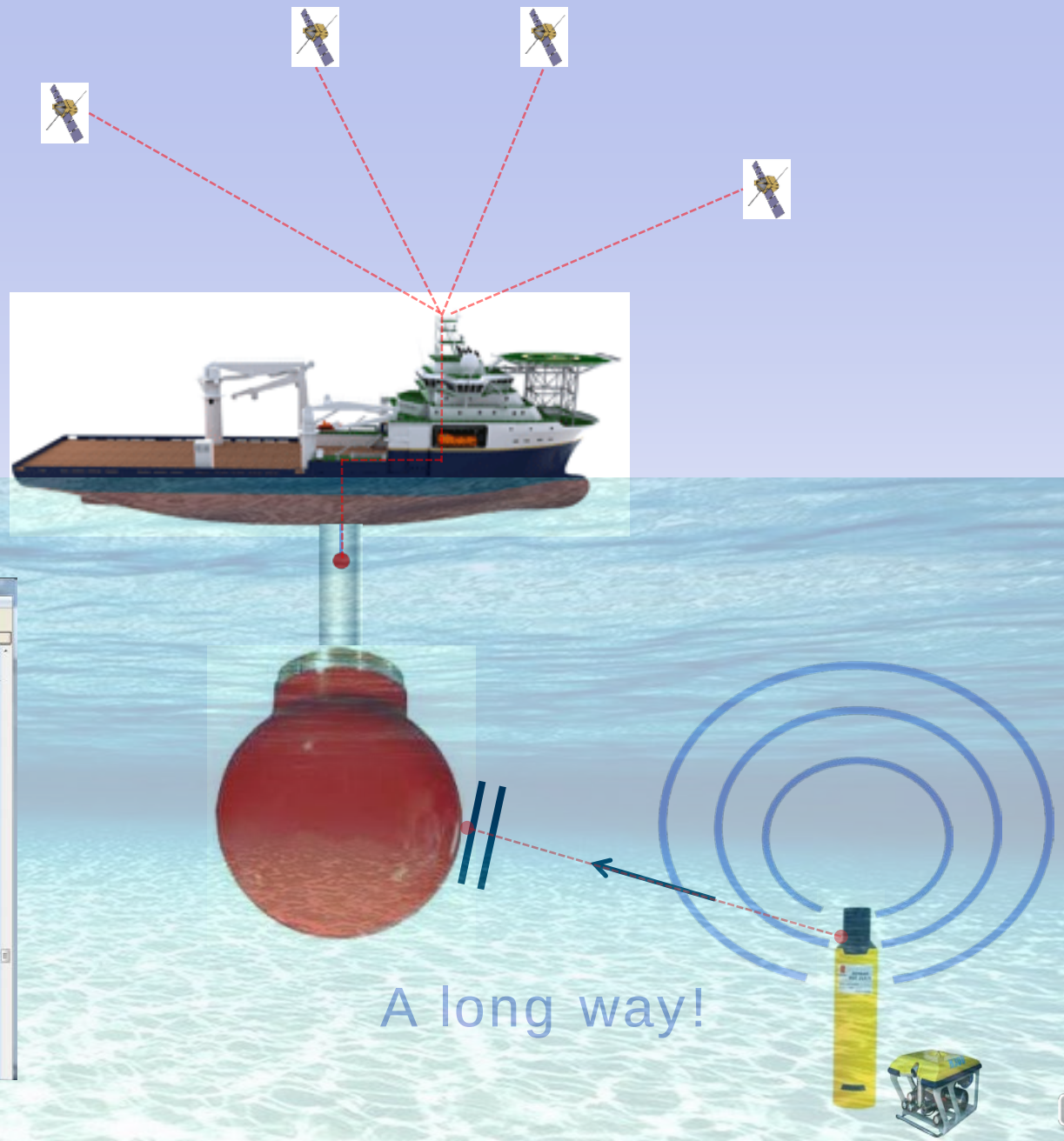
- Vessels of all shapes & sizes
- ROVs
- ROTV / towed sensors
- UUVs / AUVs (AIV)
- Subsea structures
- Surface structures
- ASVs
- Force Multipliers / Swarms!
- Highly dynamic platforms
- All require integrated survey sensors
- Let's focus on ROVs



Position

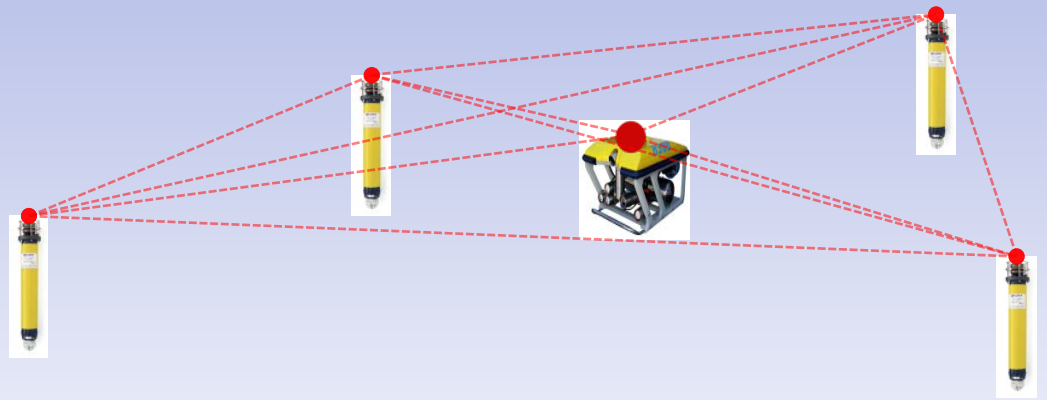
- Ultra Short Baseline (USBL)





Position

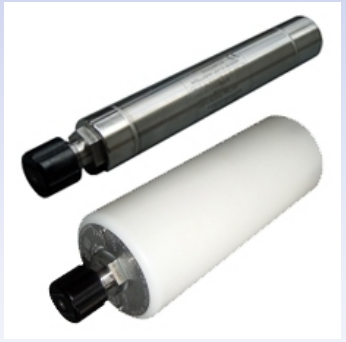
- Long Baseline (LBL)



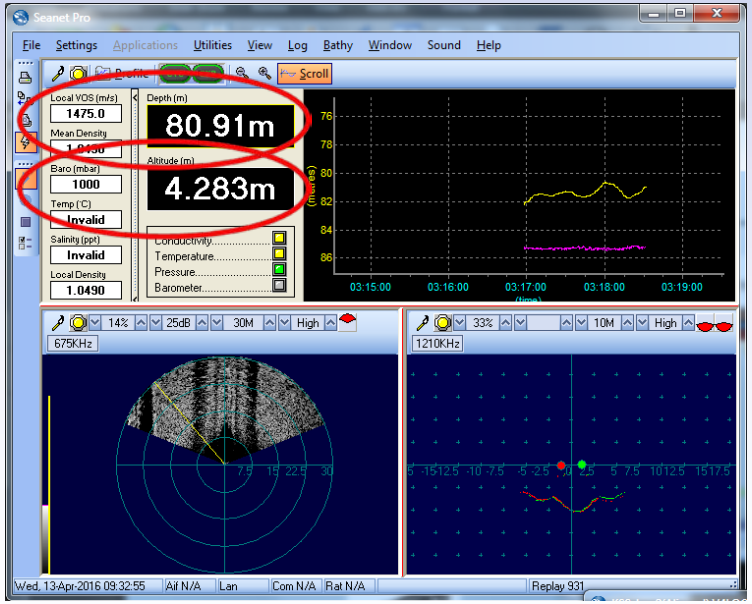
- LBL positioning consists of two main elements:
  - A network of transponders deployed on the seabed
  - A transducer fixed to a vessel
  - (either surface and/or subsurface)

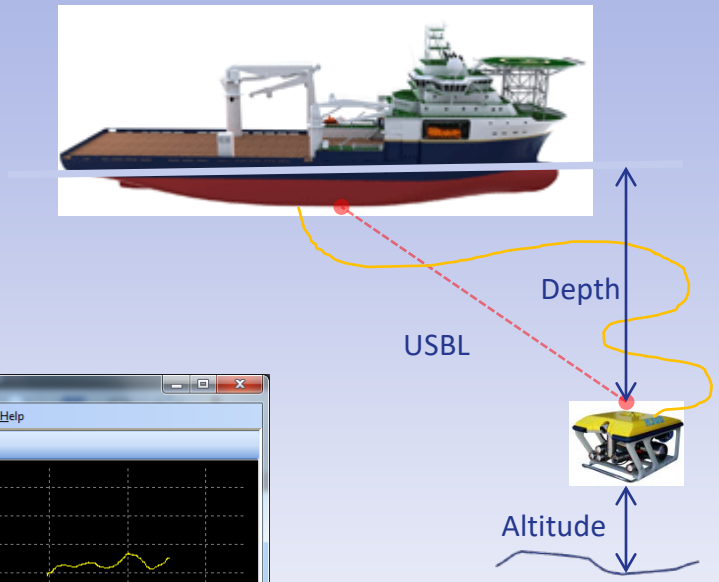
Depth / Altitude

- Essentially this can be done in two ways:
  - Depth from USBL (Z component)
  - Depth (pressure) sensor



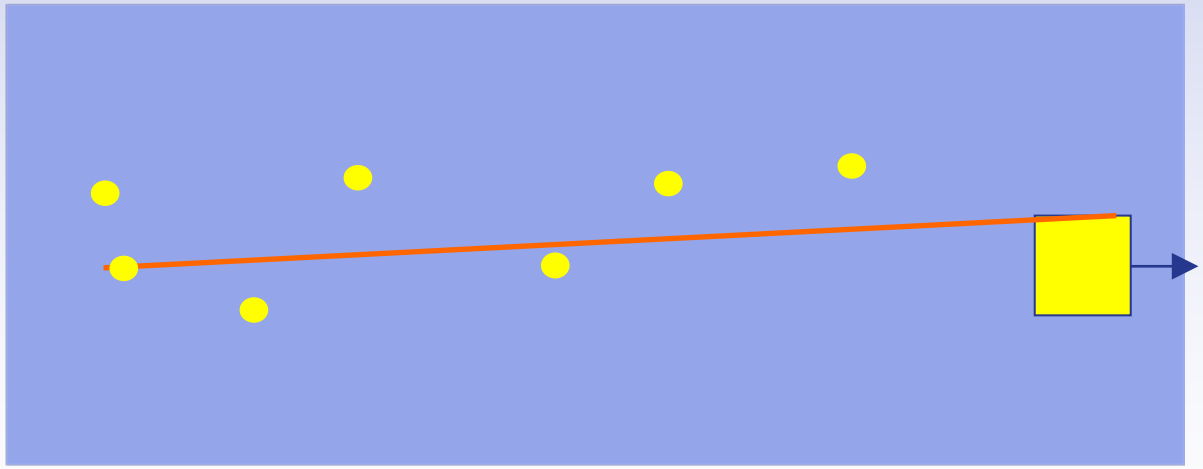
- Altitude from small HF ES





Heading

- Can be derived crudely from position track
- Not accurate enough for normal survey operations
- Heading sensor (gyrocompass) provides vehicle heading to e.g. 0.1° seclat

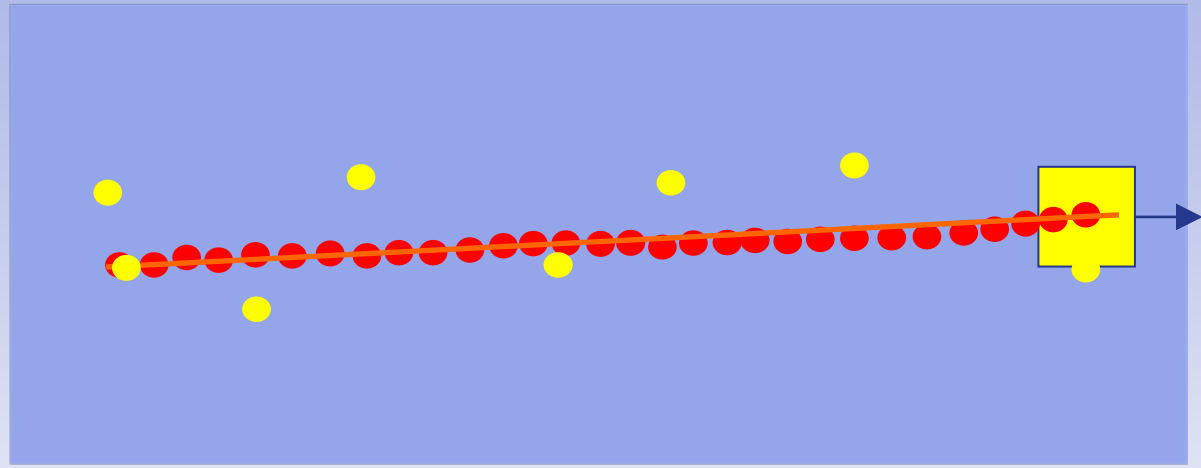


Attitude

- Pitch and roll
- Varying options depending on accuracy requirements
- Systems capable of 0.01° accuracy
- iXBlue Octans is a multiple output sensor

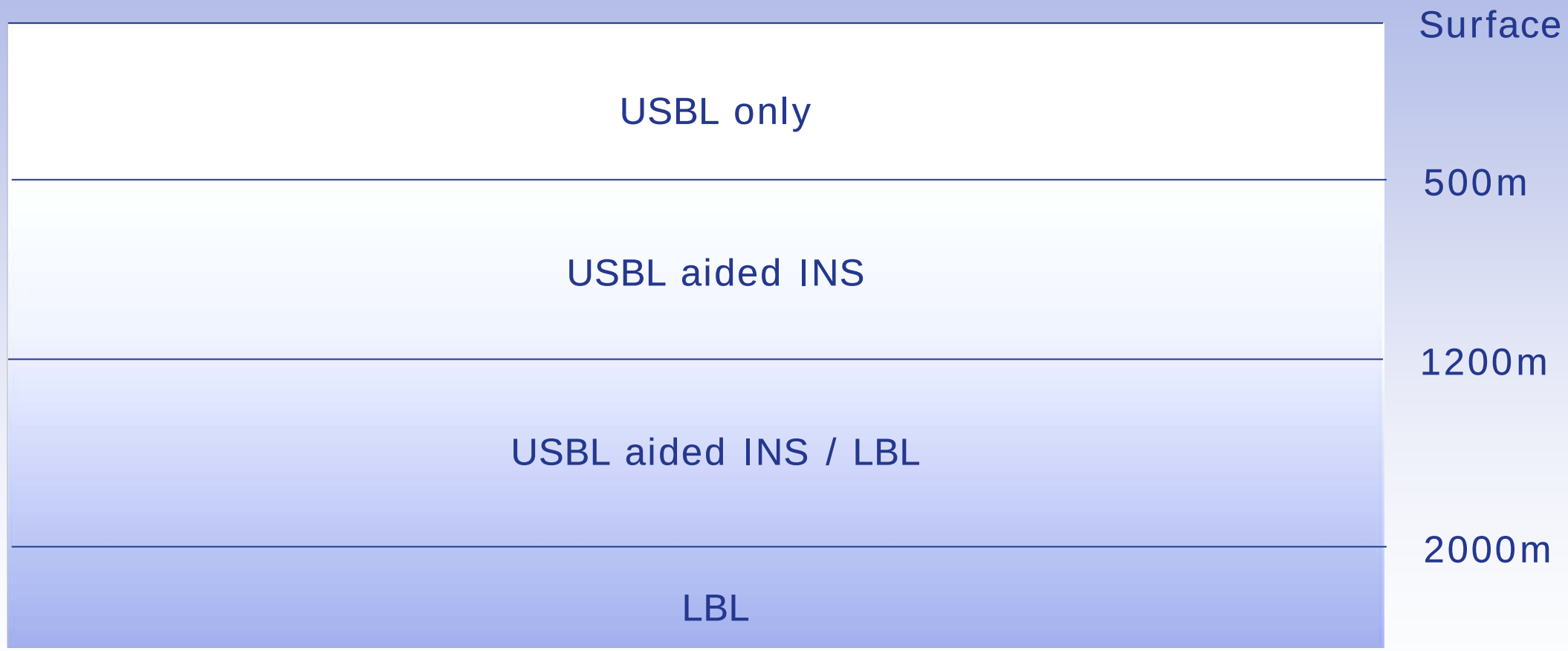
Inertial Navigation Systems (INS)

- Subsea acoustic positioning has relatively low precision and update rates
- USBL, 1-5 second update rate



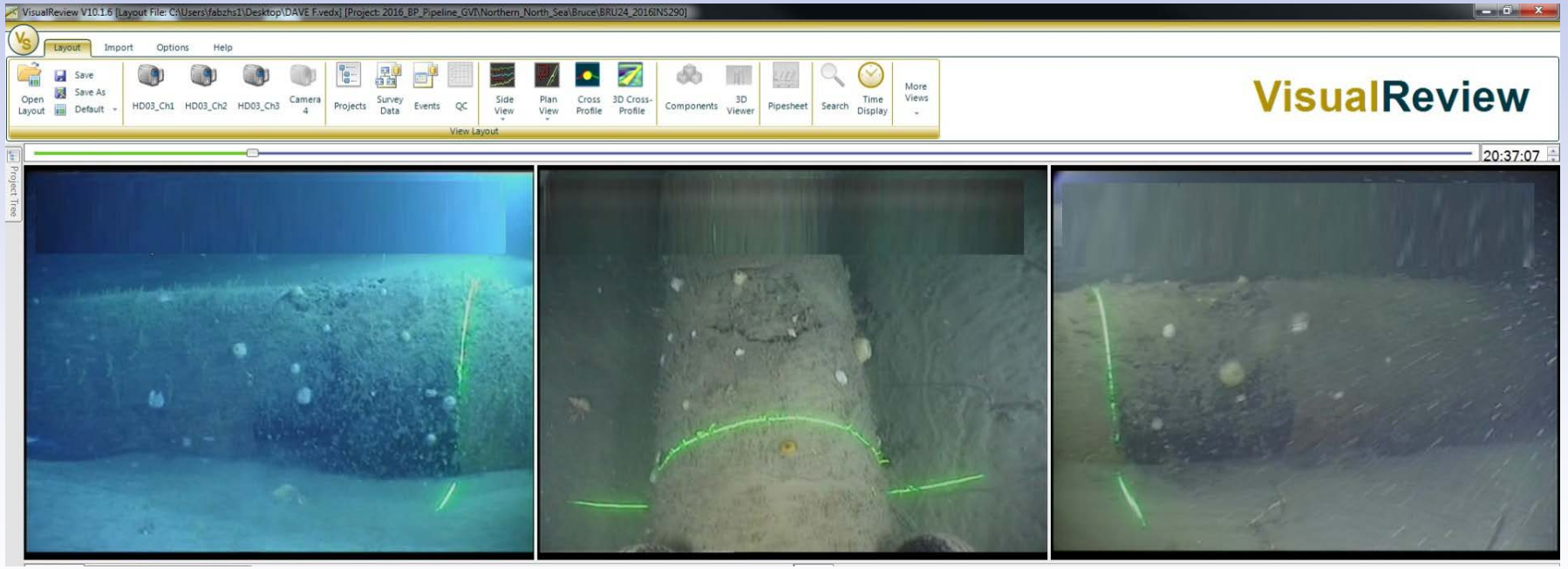
- INS aided by USBL, DVL and bathy:
  - Increased precision
  - Faster update rates
  - Provides position, heading and attitude

Rough guideline depths for use



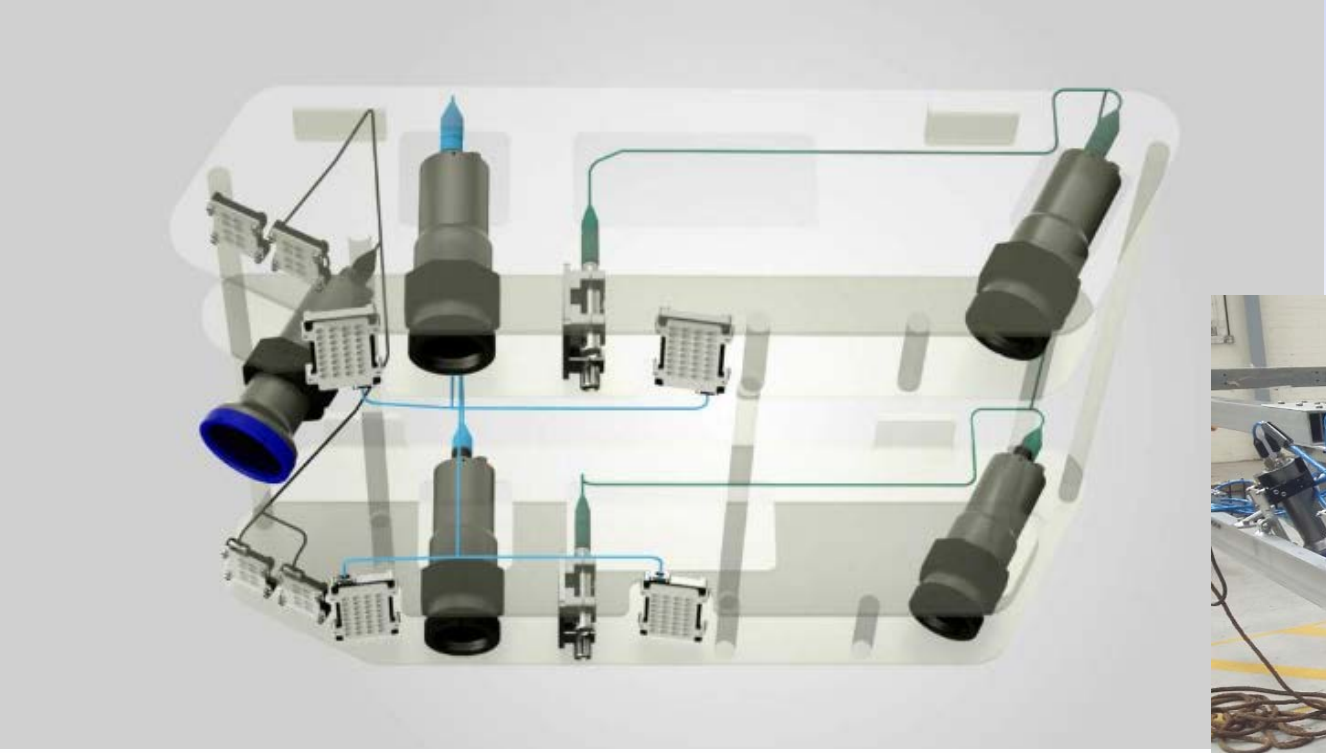
Vision

- For traditional pipeline survey typically there are three video cameras : one centre and two booms



Pipeline inspection by Fast Digital Imaging (FDI)

- Integrated camera, laser & strobe lighting
- e.g. Cathx Pathfinder



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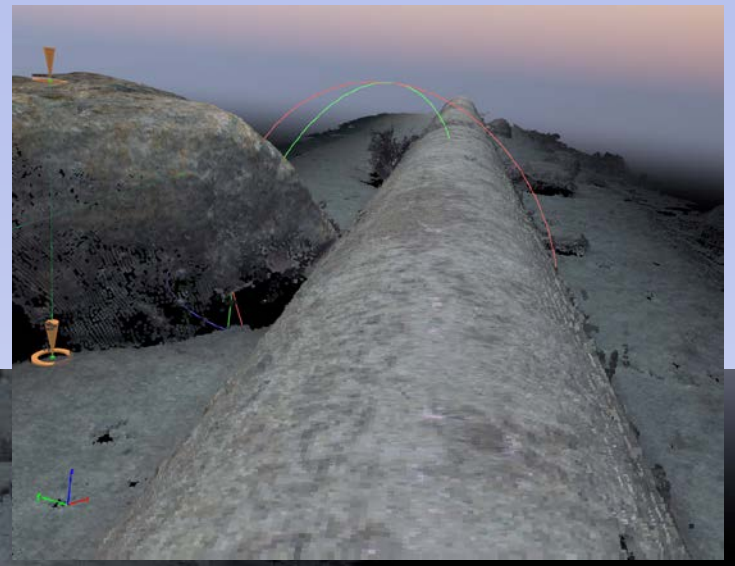
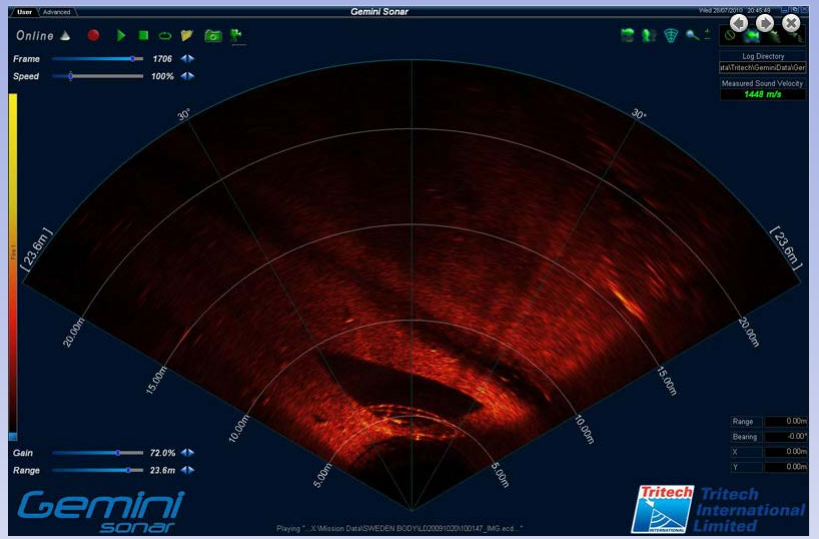
Pipeline imaging by photogrammetry / orthomosaics

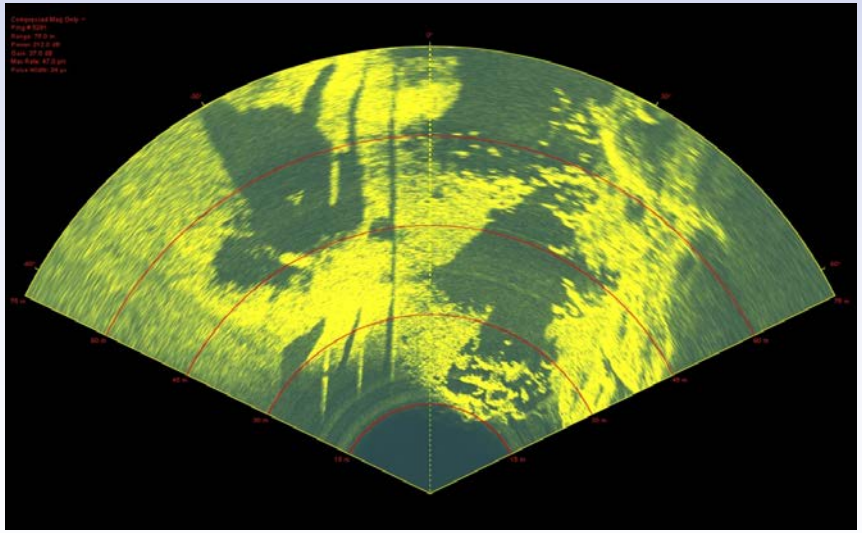


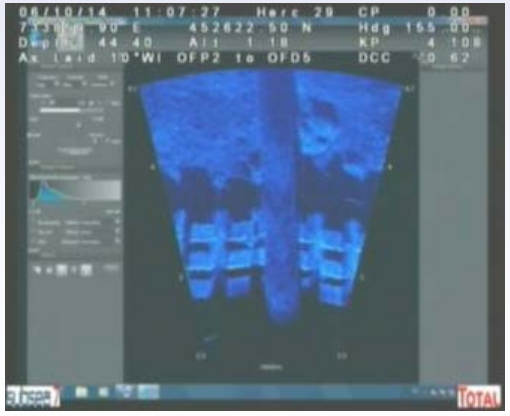
But what if there is zero visibility?

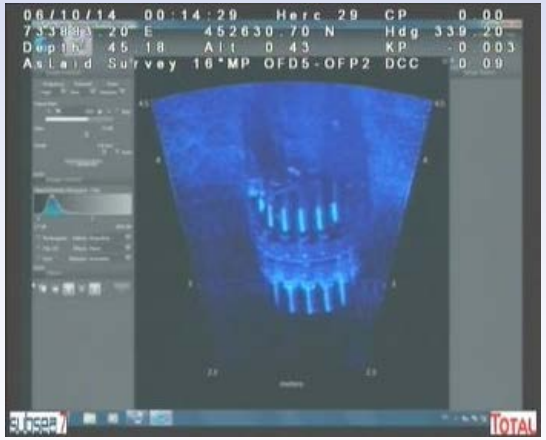
- Obstacle avoidance sonar (OAS)

- May be mechanical scanning type or beam-forming



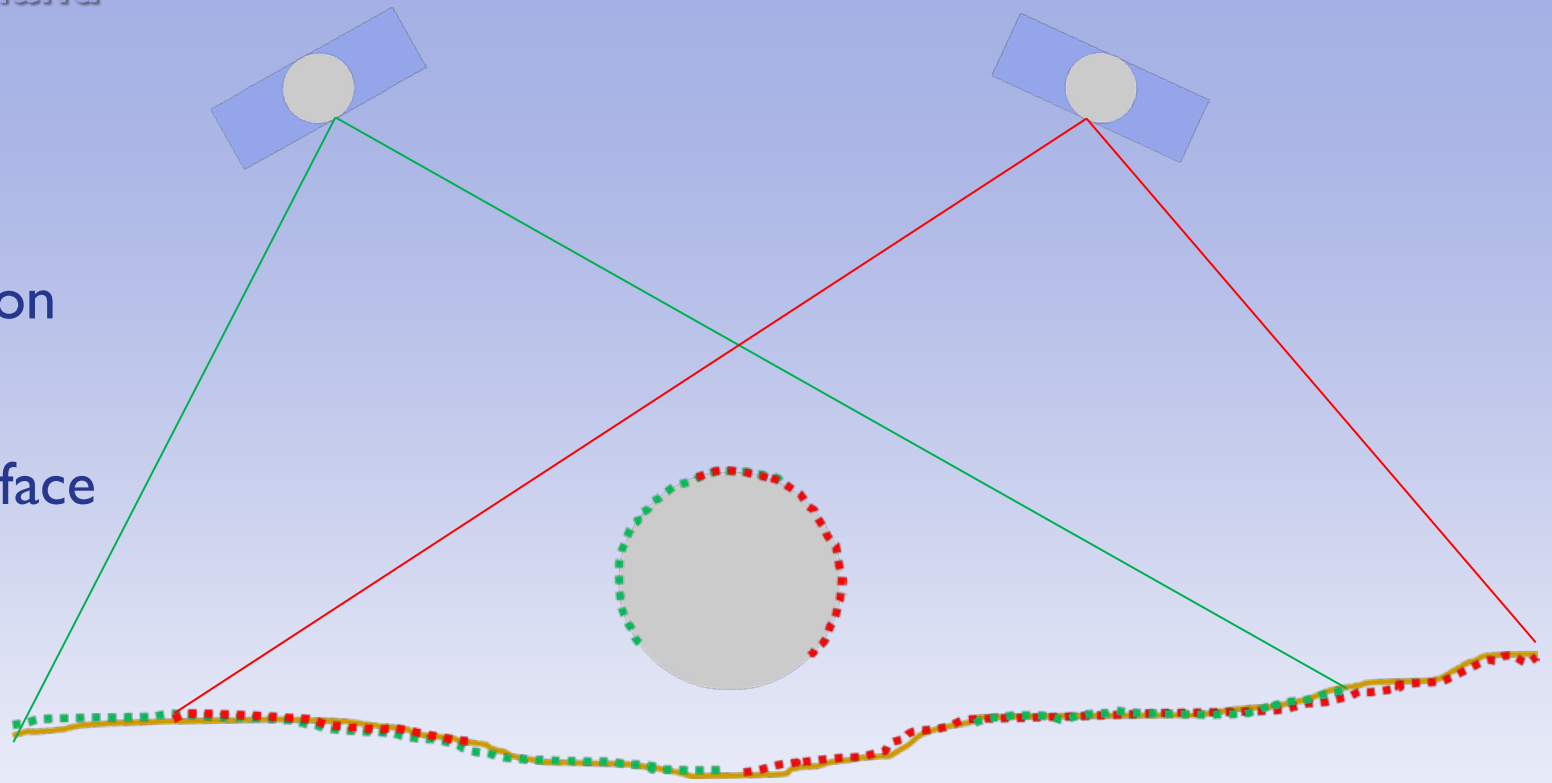






Pipeline inspection

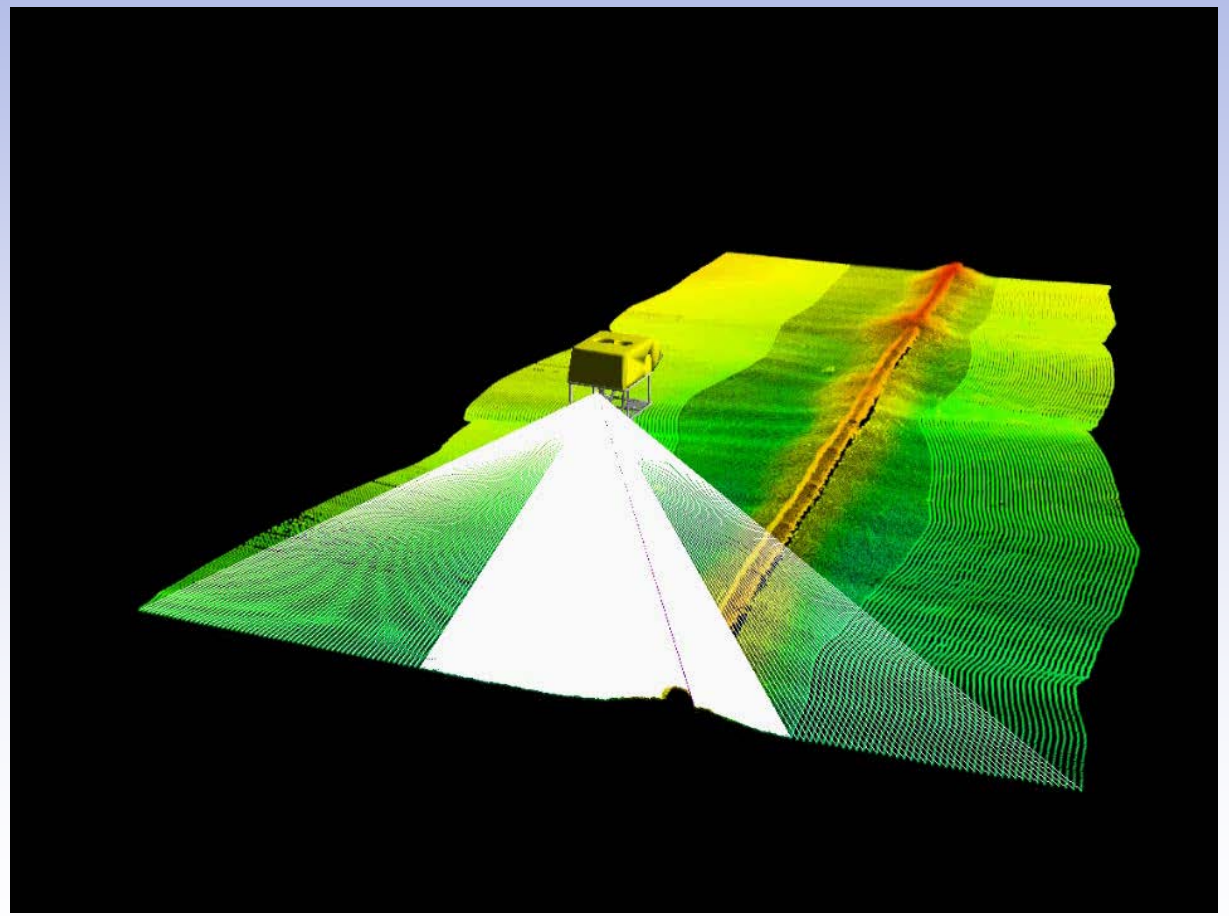
- Normally in dual head configuration
- Image pipe walls and seabed interface
- Multibeam echosounders
  - High resolution (cm)
  - Independent of visibility
- Laser profiling
  - Ultra-high resolution (mm)
  - Visibility dependent



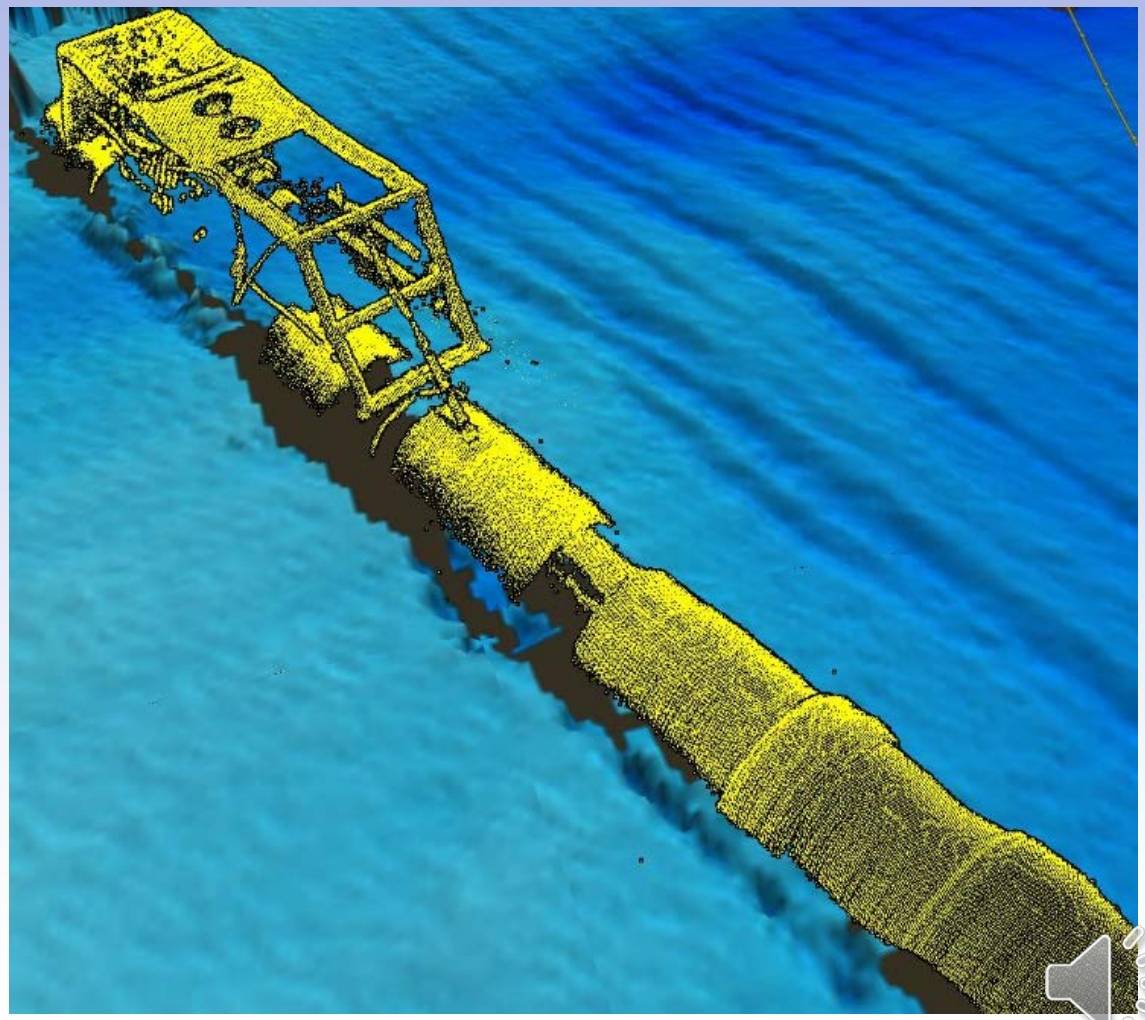
Multibeam Echosounder

Laser Profiler

Multibeam pipeline profiling



Laser profiling



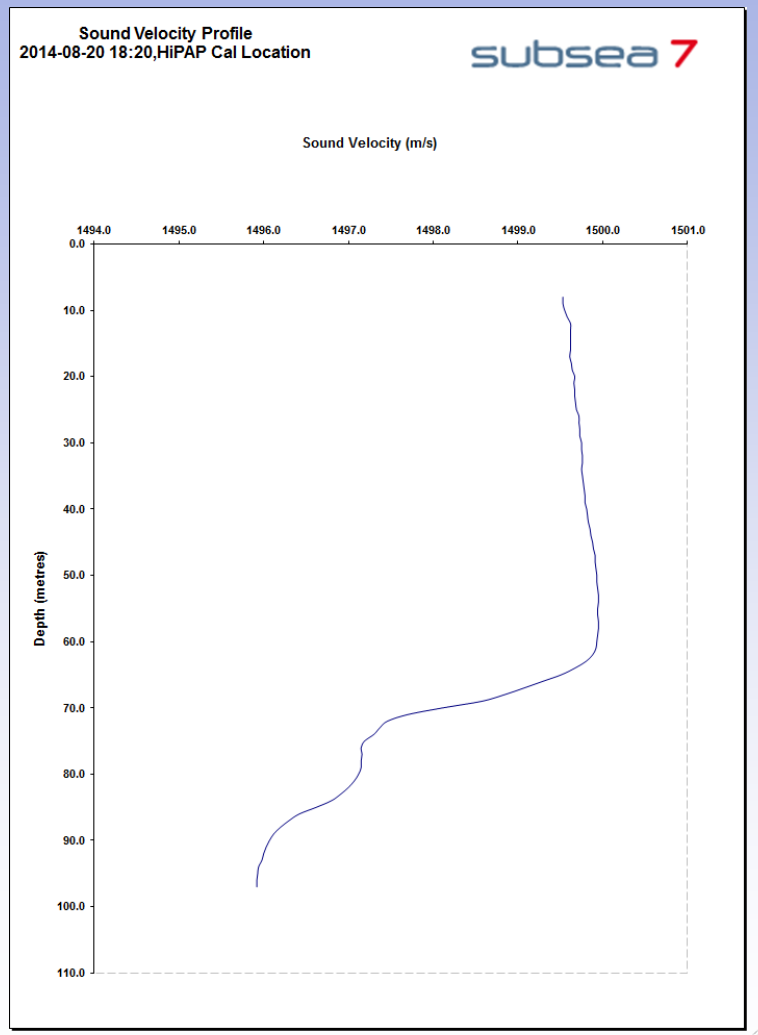
Sound velocity sensors

- SV Probe
  - Measures time of flight of an acoustic pulse over known baseline length
  - Very precise; required for MBE and LBL metrology
  - Does not provide environmental information

- CTD Probe
  - Measures conductivity, temperature and density
  - Derives sound velocity using standard formulae
    - Chen & Millero WD <1000m
    - Del Grosso WD>1000m

Sound velocity

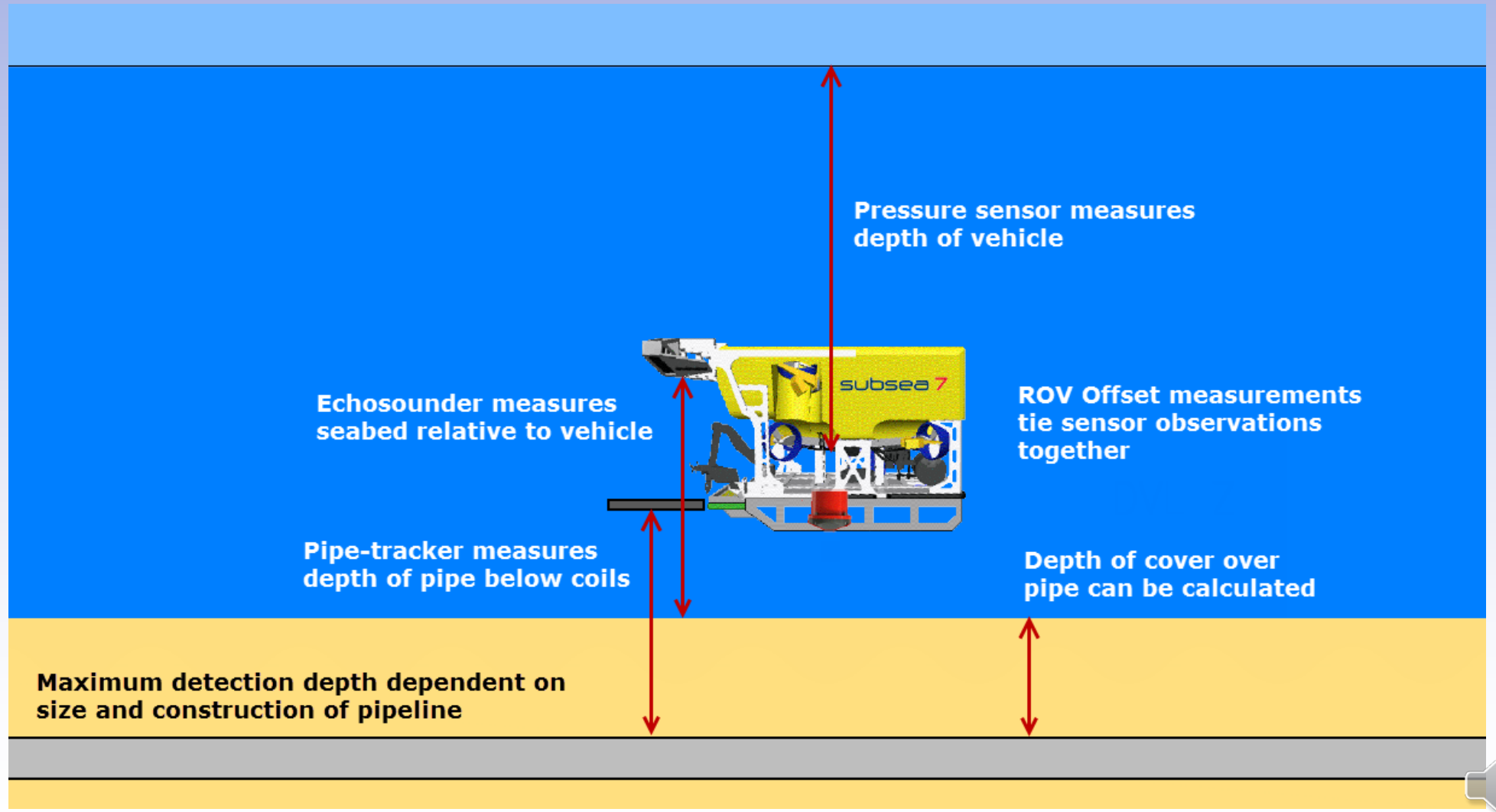
- What else is sound velocity important for?
- It is also needed to apply the full water column sound velocity profile to the USBL system to correct for refraction effects in positioning
- Sound bends through layers in the water column
- The sound velocity profile is used to model the path of sound taken



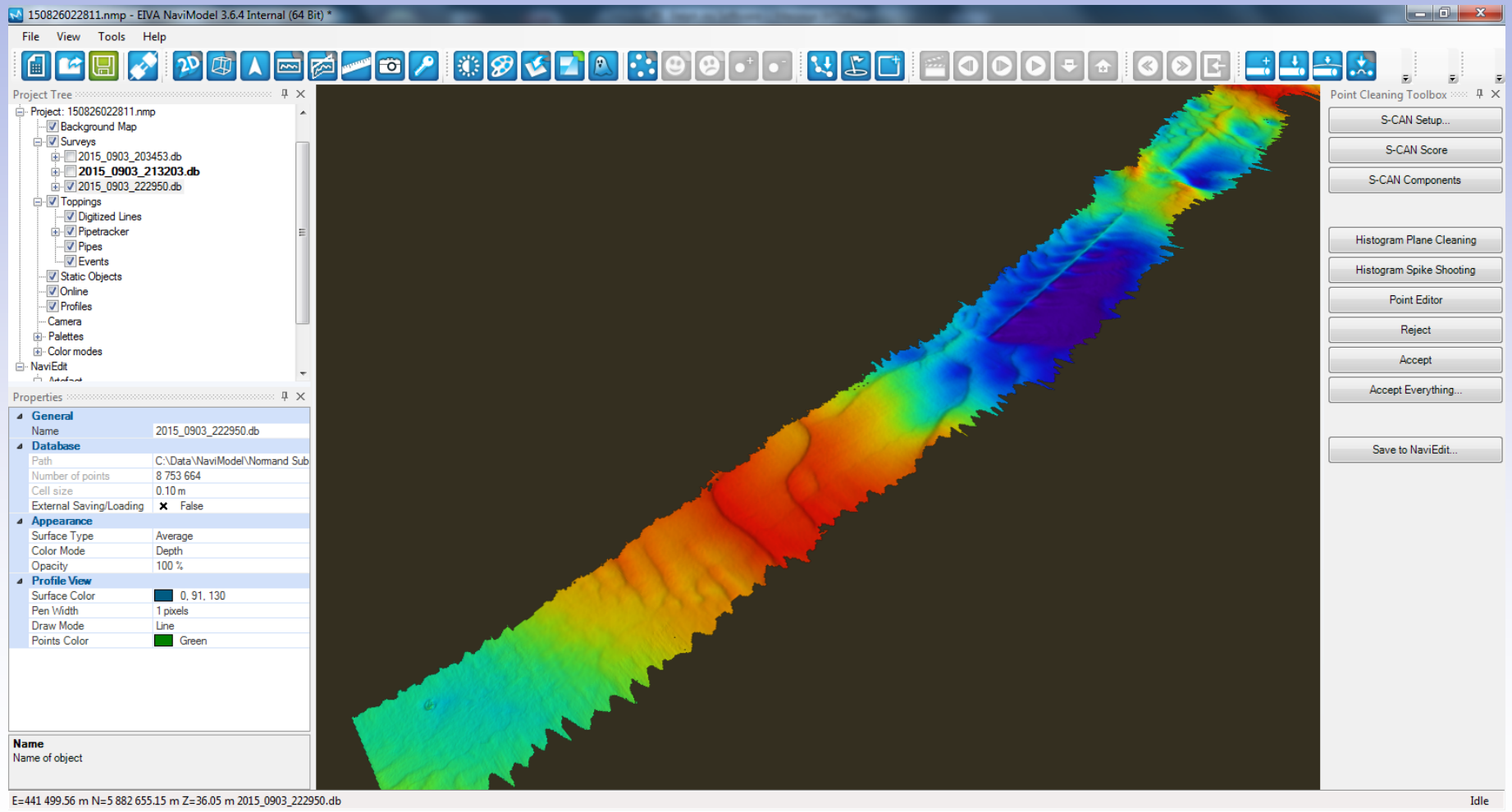
What if the product we are trying to survey is buried?

- Pipetracker
- Essentially a big metal detector – 3 coils
- Uses pulse induction techniques to induce a voltage in ferrous targets
- Calculates range to target both vertically and horizontally from centre coil
- Requires knowledge of target size and composition (diameter and material)
- Best results using "target scaling"
- Requires altimeter in order to calculate depth of cover (DOC)

Pipetracker



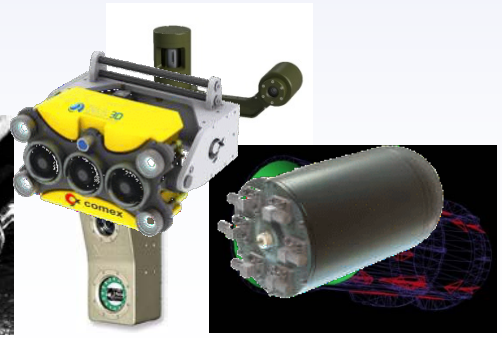
Pipeline in and out of burial

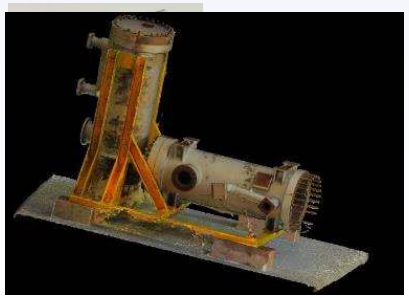


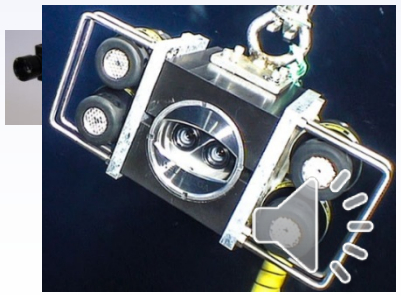
3D Imaging & Measurement

- Subsea Laser
- (scanning & profiling)

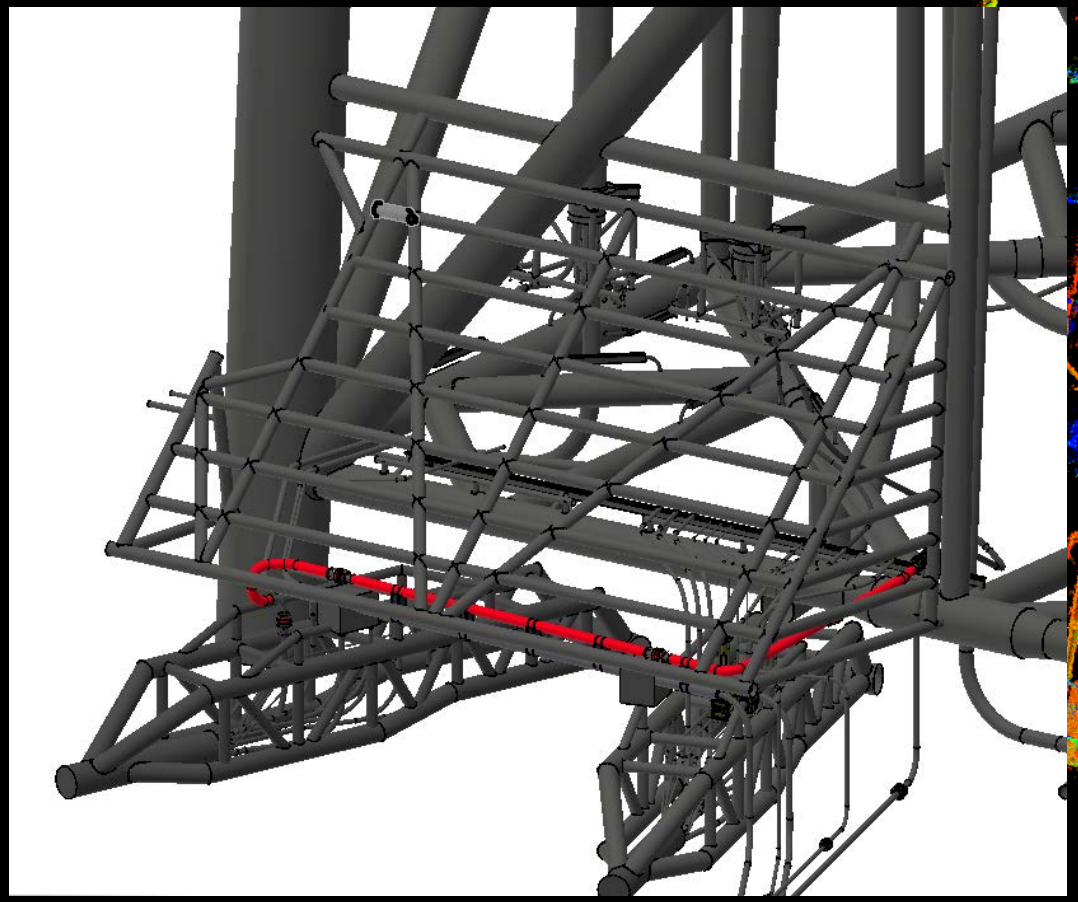
- Optical Imaging
- (photogrammetry)

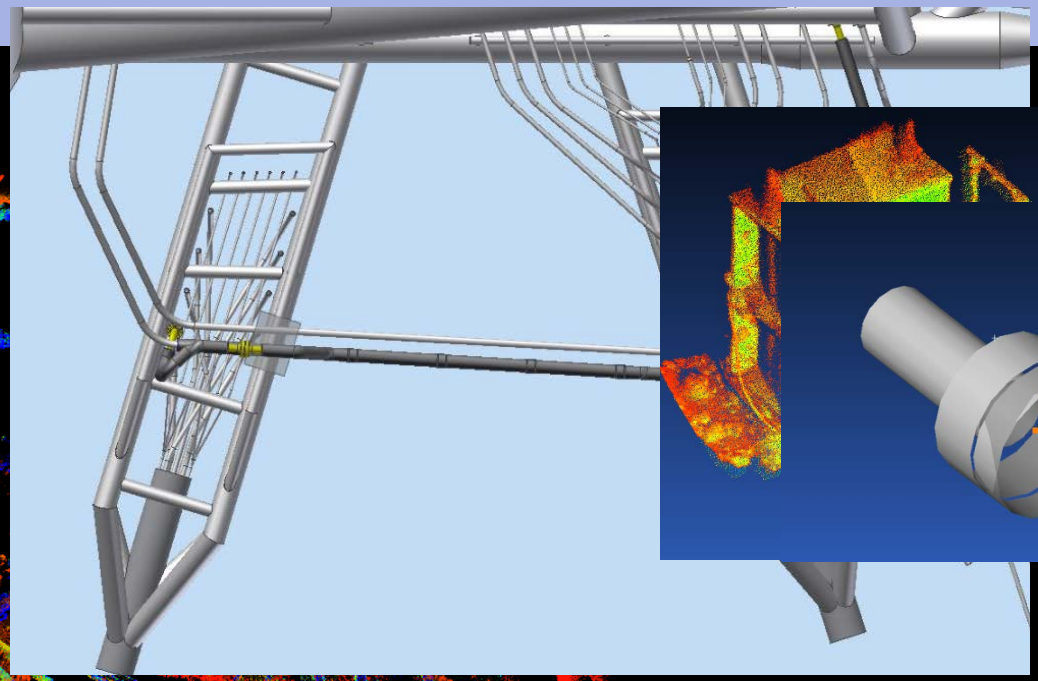


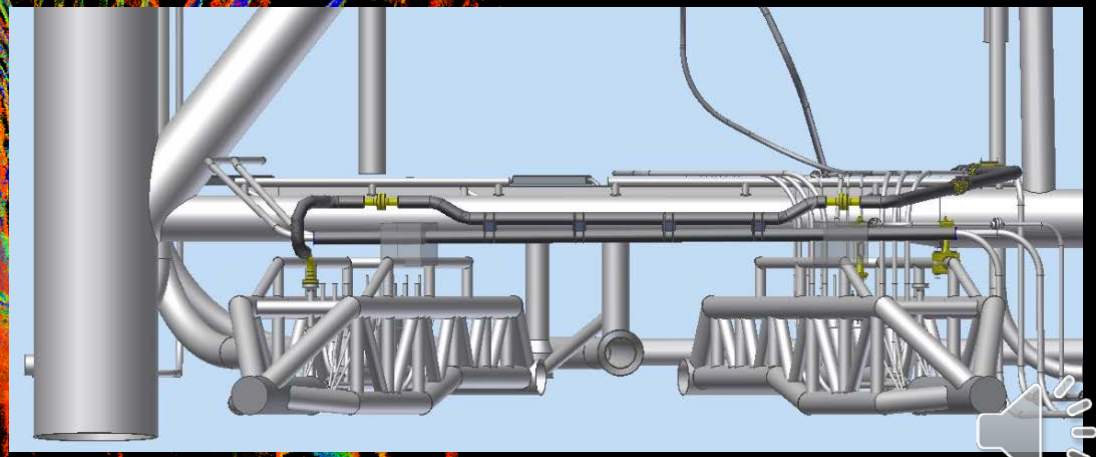




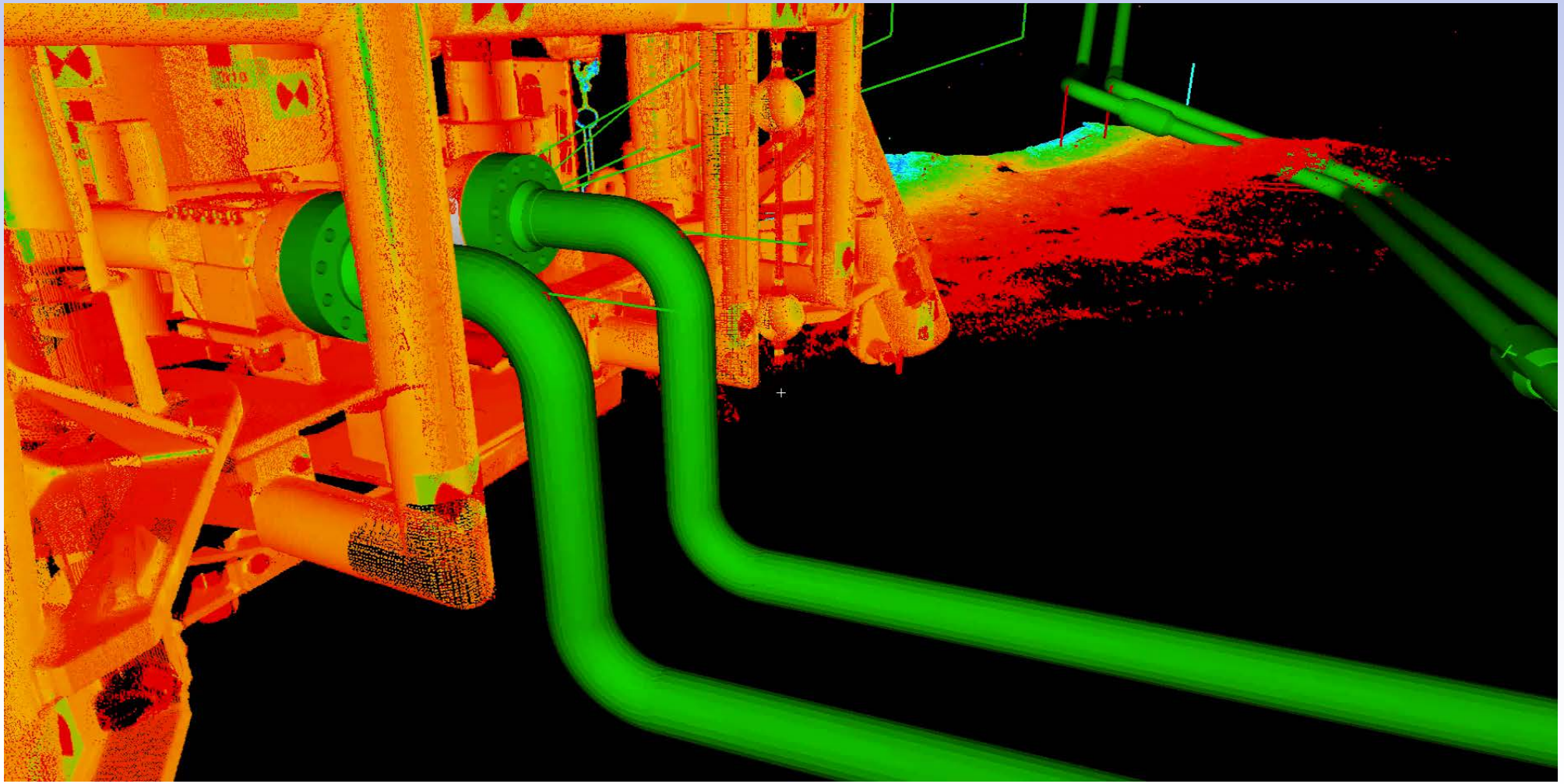
3D Modelling







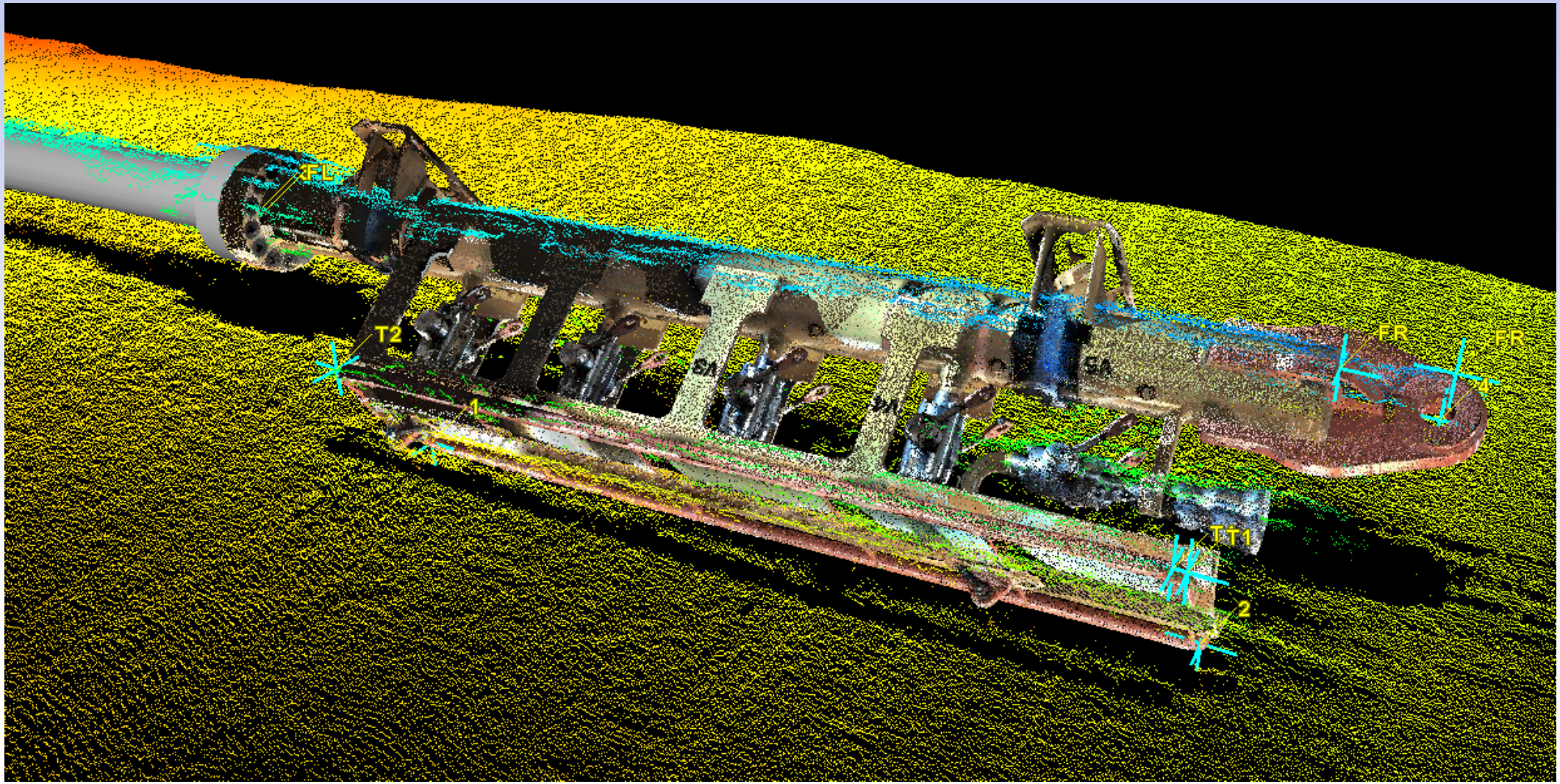
Spool metrology



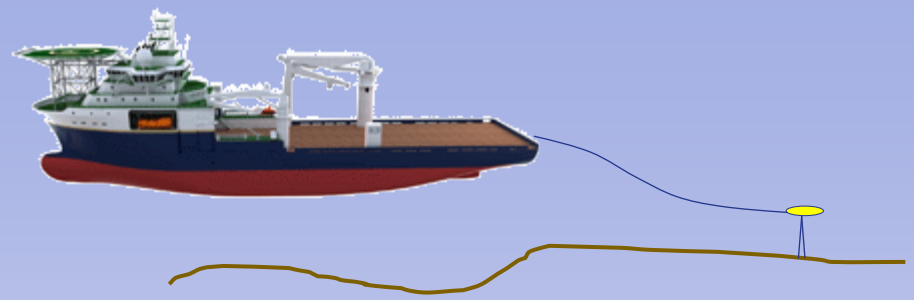
ORUS 3D
Optimal Reproduction of Underwater Sites

Photogrammetric modelling

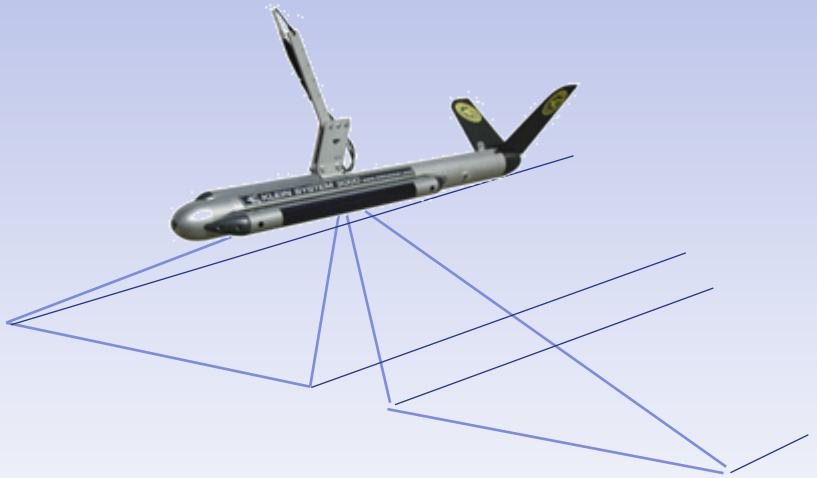
Combining data sets - topside laser scans registered into multibeam

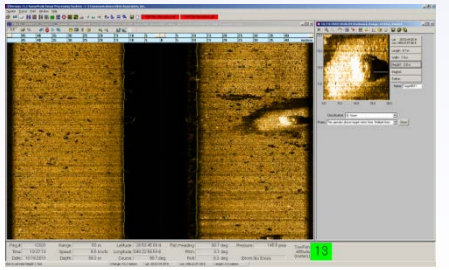


Seafloor search (area based)

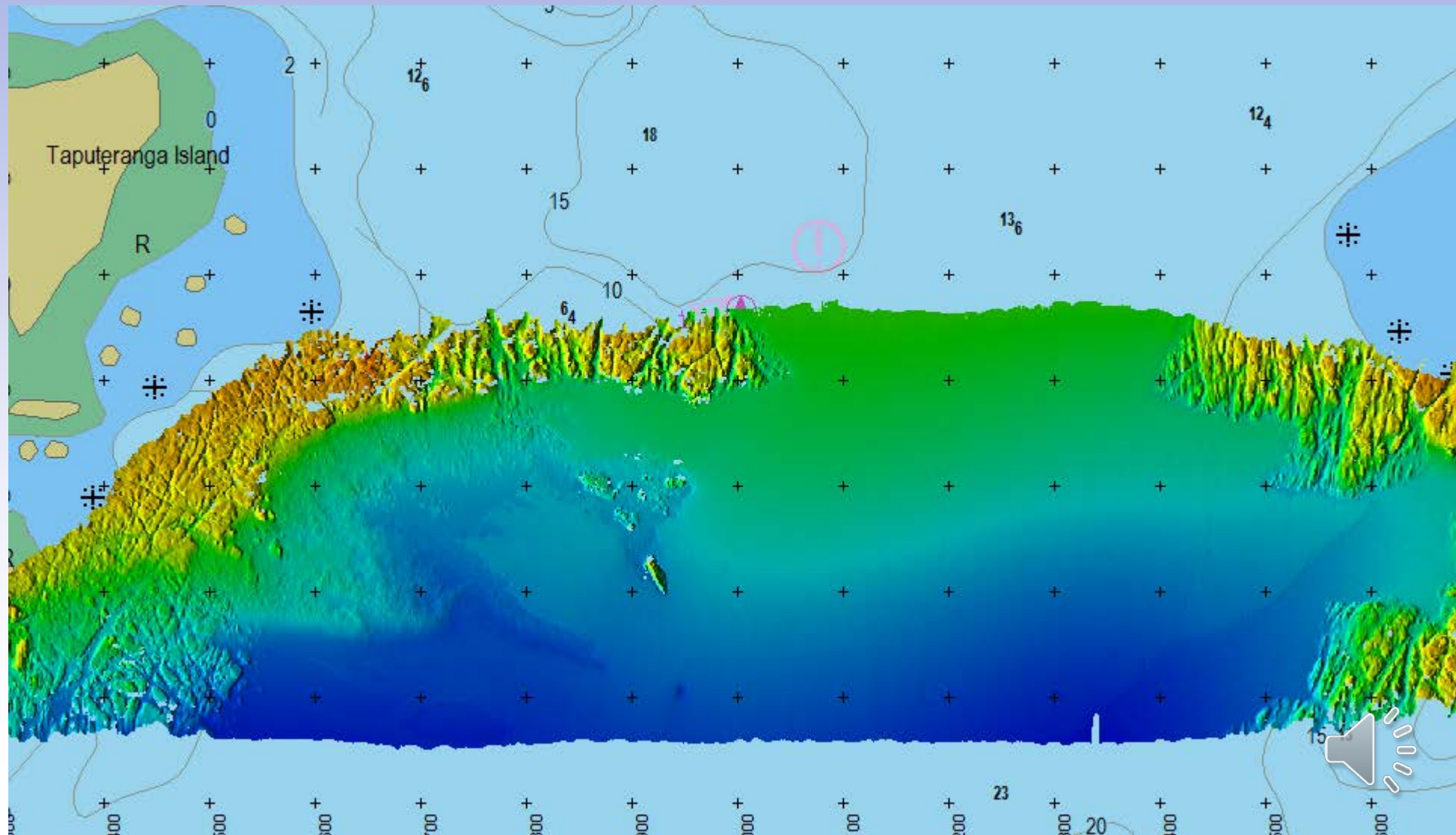


- Sidescan sonar
- 12kHz to 1200kHz
- Comprises:
  - Towed body, or "fish"
  - Armored tow cable
  - Processing electronics
  - Display
- May be used for seabed composition

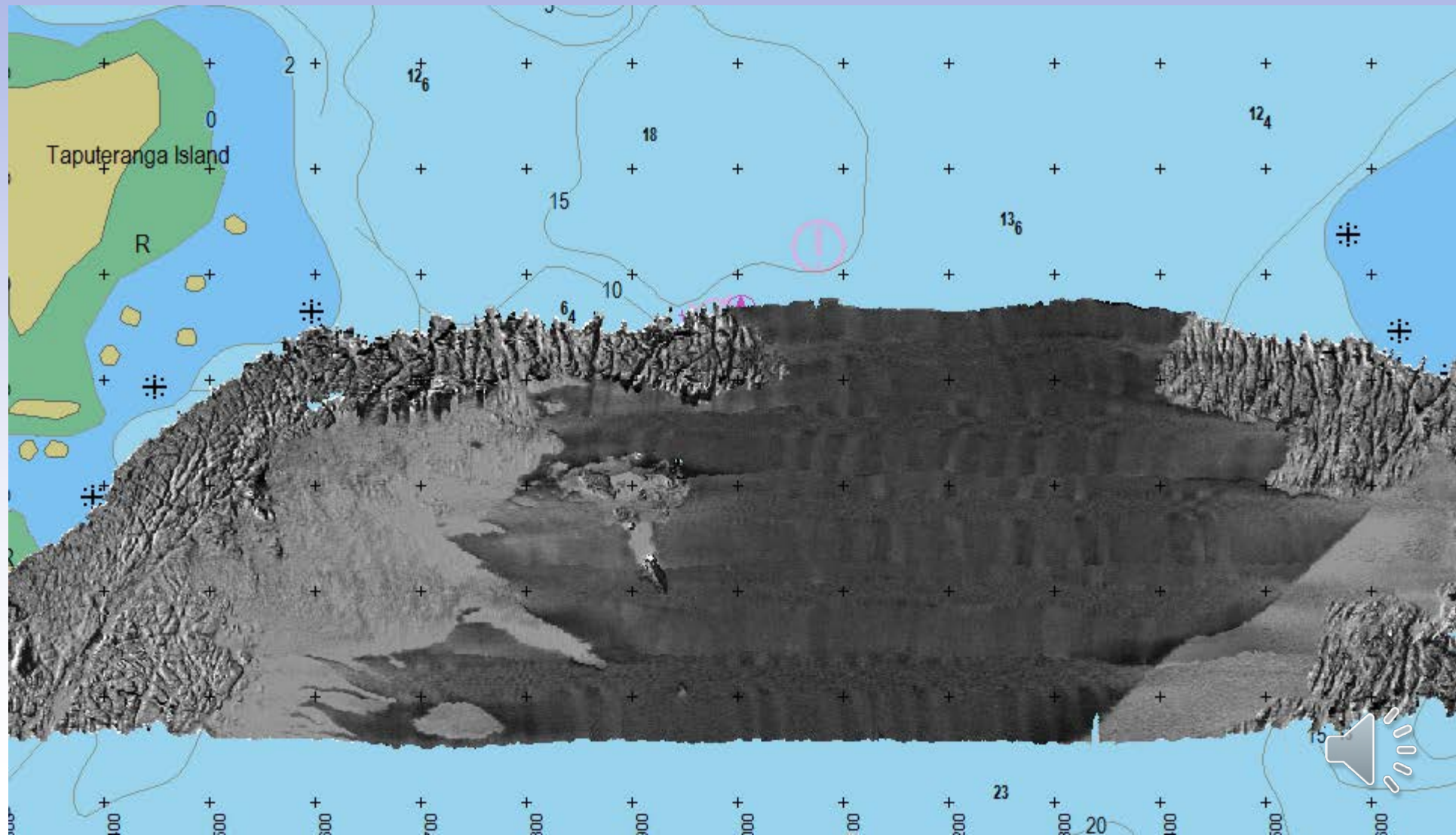




Seabed composition

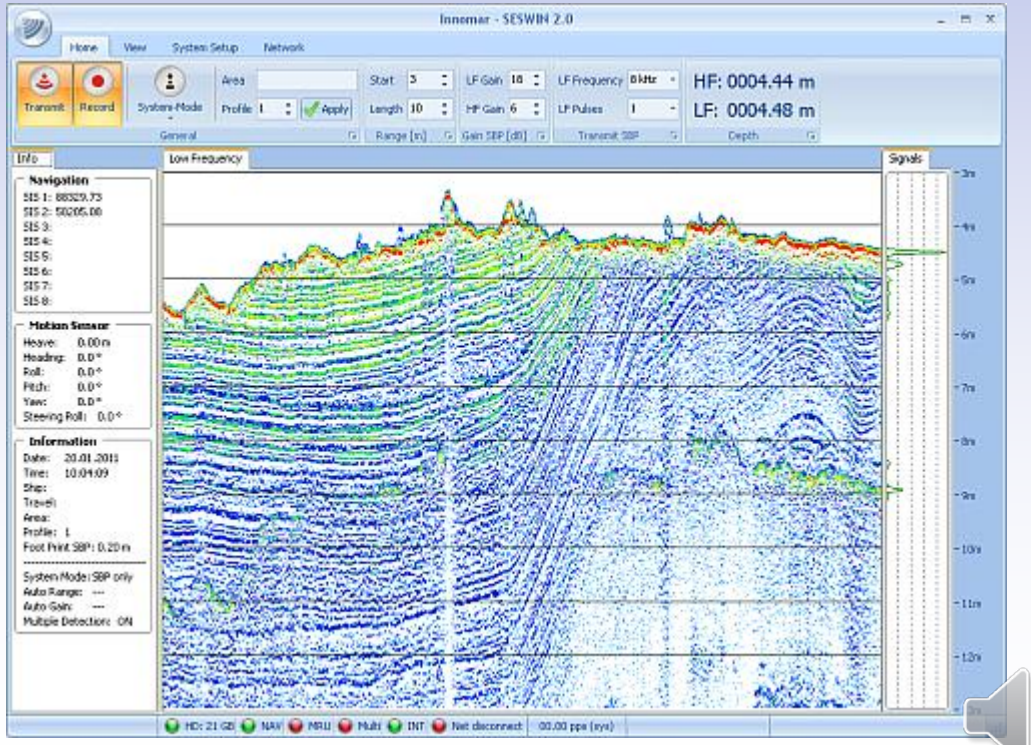


Seabed composition



What's below the seabed?

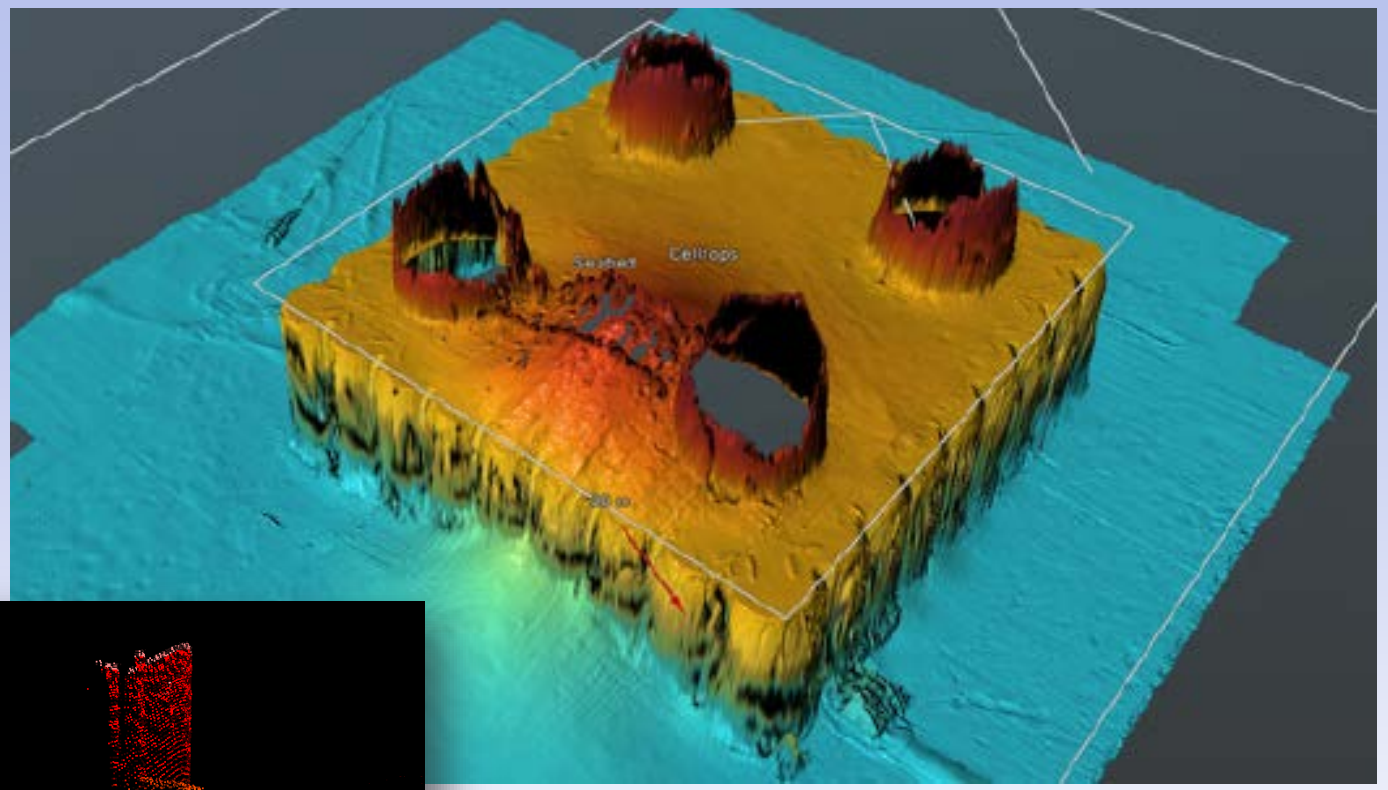
- Sub bottom profiler
- Sub seabed composition

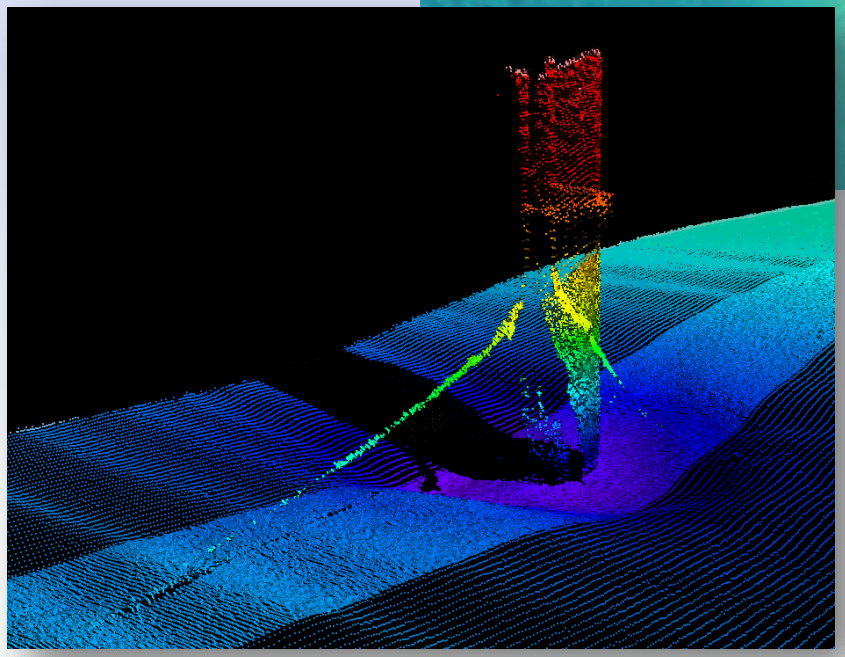


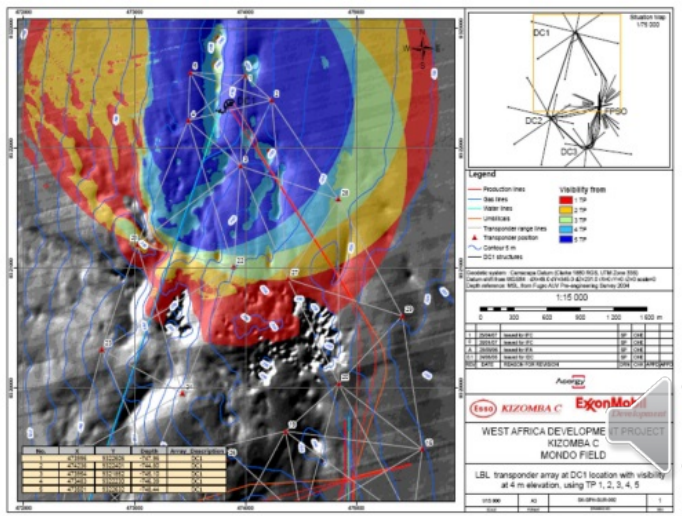
Site Investigation Survey

- Decommissioning
- Renewables

- Multibeam
- Sidescan
- Sub bottom profiler







Summary: software integration

Survey Sensors

17/04/2020

Danny Wake

Chief Surveyor

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